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Casting Chevrolet Cylinders

Details of Core Making, Venting, Method of Setting and Adjusting Cores, Are Described Together with General Features Involved in Making the Mold—Equipment is Adequate

UNLIKE many of the motor car manufacturers, the Chevrolet Motor Co., a subsidiary, of the General Motors Corp., does not maintain a gray-iron foundry for the production of its castings. Some of them are made in foundries controlled by the General Motors Corp., and others are made in independent foundries which specialize in motor casting work. The orders are given in lots that will reimburse the foundryman for special and extensive rigging designed to produce the castings economically in large quantities. The same gen-

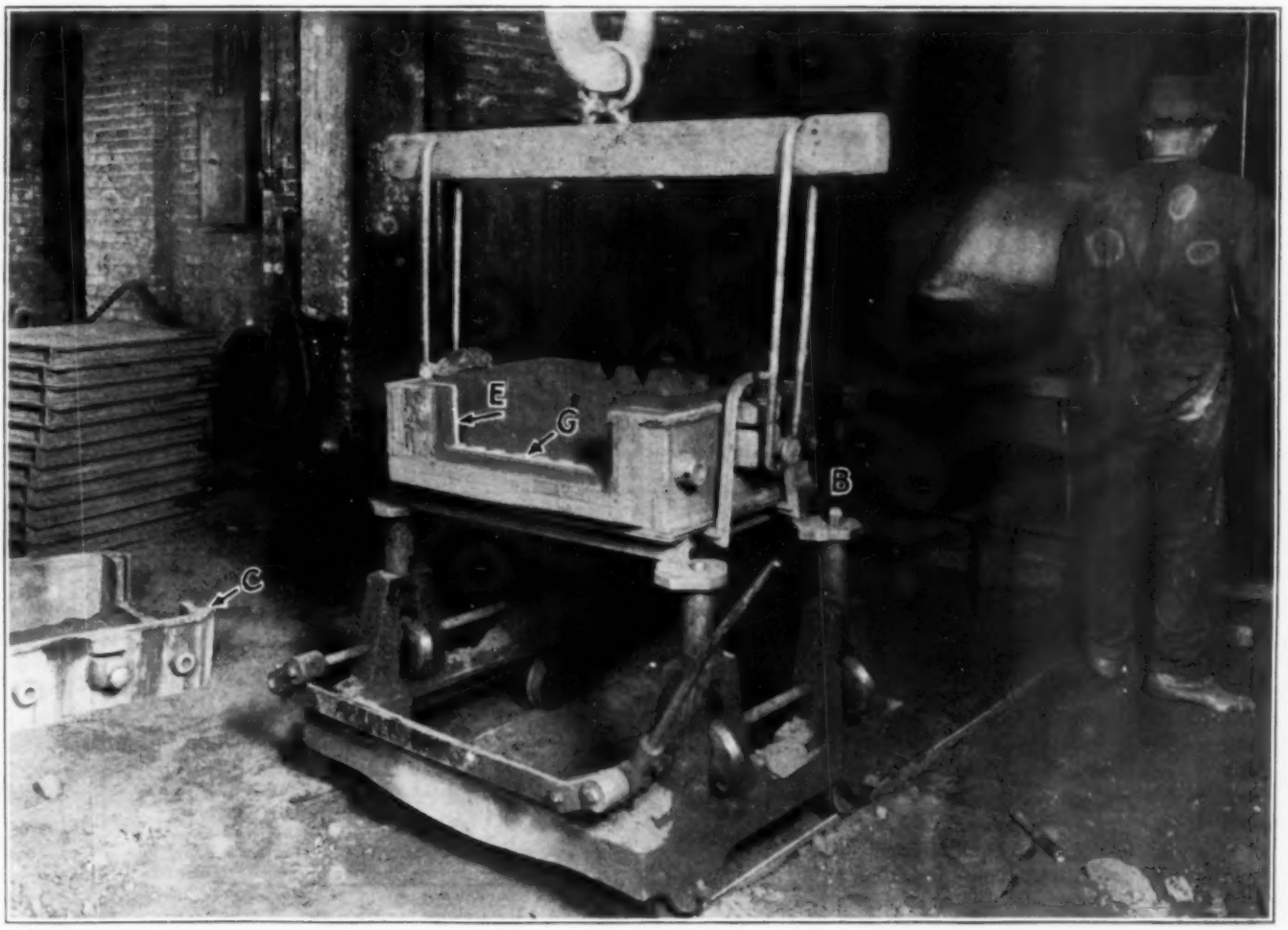


FIG. 1—THE FLASK IS CUT OUT ON BOTH SIDES TO FACILITATE THE SETTING OF THE CORES—THE U-SHAPED CLAMP AT EACH END SUPPORTS THE BOTTOM PLATE UNTIL THE DRAG IS PLACED ON THE FLOOR

FIG. 2—THE CASTING IS POURED THROUGH A SINGLE RUNNER IN THE COPE COINCIDING WITH A SIMILAR RUNNER IN ONE OF THE BODY CORES—THE IRON ENTERS THE MOLD THROUGH A NUMBER OF FLAT, BRANCH GATES FORMED IN THE EDGE OF THE LOWER CORE PRINT

eral plan is followed in all the foundries handling these patterns but minor changes here and there reflect the individuality of the man directly responsible for designing the rigging and outlining the method of production in each case. Details of some of the methods and rigging employed at the Detroit Foundry Co., Detroit for producing the cylinder block are shown in the accompanying illustrations.

It may be noted that he cylinder is of comparatively plain design and embraces only the upper half of the crankcase and the water-jacketed barrels. The firing chamber and valves all are in th ecylinder head which is formed as a separate casting. The four intake and four exhaust valves are operated through openings in the top of the cylinder head by rocker arms actuated by vertical rods that receive their impulse from a camshaft located in the lower part ofthe cylinder block frame.

Pattern Parted Vertically

The pattern is parted in a straight line, vertically through the center, considering the position of the casting when in use, that is, with the barrels up and down; but it is molded and cast horizontally as shown in Fig. 6. Half patterns of white metal accurately machined and fitted to suitable plates are mounted on two jar-ram, rollover machines made by the Grimes Molding Machine Co., Detroit, one machine for the copes and the second for the drags. The flasks are cut out at one side for the large square coreprint of the body core; that is, the part of the core which forms the opening in the lower part of the cylinder block connecting with a corresponding opening in the upturned side of the crankcase. The flask is cut out on the opposite side for the ends of the cylinder barrel cores.

By referring to Figs. 1, 2 and 6 it may be noted that in addition to eliminating the usual body of sand behind the core prints, on both sides, the flask hugs the pattern closely on each end. The ends also could be cut out to conform to the outline of the pattern were it not necessary to provide guide lugs and handles. As it is, the amount of sand required to fill each flask has been reduced to a minimum. A reinforcing strip around the edge of the flask top and bottom and also around the openings, compensates for the apparent weakness of construction and enables the flask to stand up to the comparatively rough usage incident to the employment of semiskilled help. The flask joint is machined so that it will rest perfectly flat on the pattern plate, and also that when the cope and drag are assembled the edges of the flask will touch each other all points. With a larger sand bearing, it might not be so essential that the joints on the flask should concide exactly, but in this case the sand bearing is so limited that the weight of the cope would crush the sand joint if it were not supported as shown.

The style of handles adopted for the flask, and also the shape and location of the guide lugs, clearly are indicated on the flask shown in the illustration, Fig. 2. With these handles the flasks may be manipulated either by hand or by the crane. Dry-sand cores of the required shape, rammed against the ends of the flask pattern, form the lugs and handles, while loose strips drawn into the mold cavity after the main pattern is drawn, serve to form the reinforcing strip around the edges. Loose pipe handles inserted in the holes in the handle lugs, and removed after use, are employed when the flasks are lifted by hand. It is claimed this device is an improvement over the ordinary style flask in which the pipe handles are cast in place. The men engaged in making the cylinder molds, from the nature of the work, must handle the flasks carefully, but the men who shake them out by night are under no such restrictions and as a result, pipe handles that are cast in, frequently are bent and sometimes broken. The detachable handles are provided in deference to the proverb that an ounce of prevention is better than a pound of cure.

Prevents Accidents

The trunnions at the ends are attached to extension brackets, a precaution that insures the flask swinging clear, and also prevents the slings from striking either the handles or the special clamp shown at *B*, Fig. 1. Too, it eliminates a potential source of accident by which men sometimes wound and occasionally loose one or more fingers, between a sling and the close fitting edge of a revolving iron flask. The cope is provided with several bars extending from side to side in the usual manner, but the drag is a plain open frame to which a bottom plate is attached to hold the sand forming the mold.

The drag is placed on the pattern

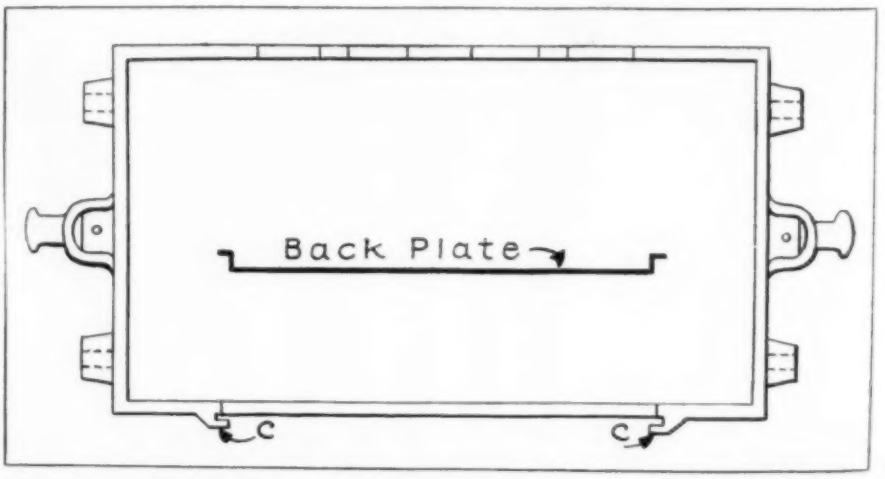


FIG. 3—DETAIL OF STEEL PLATE ATTACHMENT EMPLOYED FOR SECURING OPEN SIDE OF THE MOLD AFTER IT HAS BEEN ASSEMBLED

plate on the machine, where it is filled with sand and jolted to the required density. A little experimenting usually is necessary to determine this point, but once a standard has been established the element of chance incident to hand ramming is eliminated, for the machine uniformly will ram every mold to the same density. After the drag has been rammed, the top surface is scraped off flush with the edge of the flask and iron bottom plate, provided with stiffening ribs is attached to the flask by special U-shaped clamps, one of which is shown at *B*, Fig. 1. The upper end fits over the guide-pin lug while toes on the lower end engage he end of the bottom plate. Pattern and mold are elevated and rolled over by the machine and then lowered on to the carriage shown in the foreground of Fig. 1, which is pushed in under for that purpose.

The core *G* which forms a set of thin branch gates all along the bottom edge of the casting, and the cores *E*, one on each side of the rectangular opening, which merely serve as reinforcements at the corners and obviate the necessity of shaving the print before lowering the body cores, then are set. After this is done the crane conveys the drag to its appointed place on the floor. The *U*-clamps are removed and returned to the vicinity of the machine in time to be used on the following mold. Six men constitute a crew, two men on drags, two men on copes, and two men setting the cores and closing the molds.

The system is elastic to a certain extent and can be adapted to meet varying production schedules. For instance, three or even four men can be placed at each machine and a corresponding number on the closing floor. It is a disadvantage to have more than four men on a machine, in fact, the production steadily falls off in proportion to any number over two, and for that reason the crew usually is held to that number. Conversely, although sometimes it may be necessary to work one man on each machine, or even use one machine both for cope and drag by changing patterns after the required quota of drags has been made, the production cost per mold is higher in su hccases han when the six-man crew is employed. When the production schedule exceeds the capacity of two machines, additional machines are switched from other work and pressed into service. If necessary, it is claimed, a daily schedule of 400 cylinders could be maintained, but usually from 75 to 100 constitutes the day's output.

By referring to Figs. 4 5 and 6 showing respectively the corebox for making

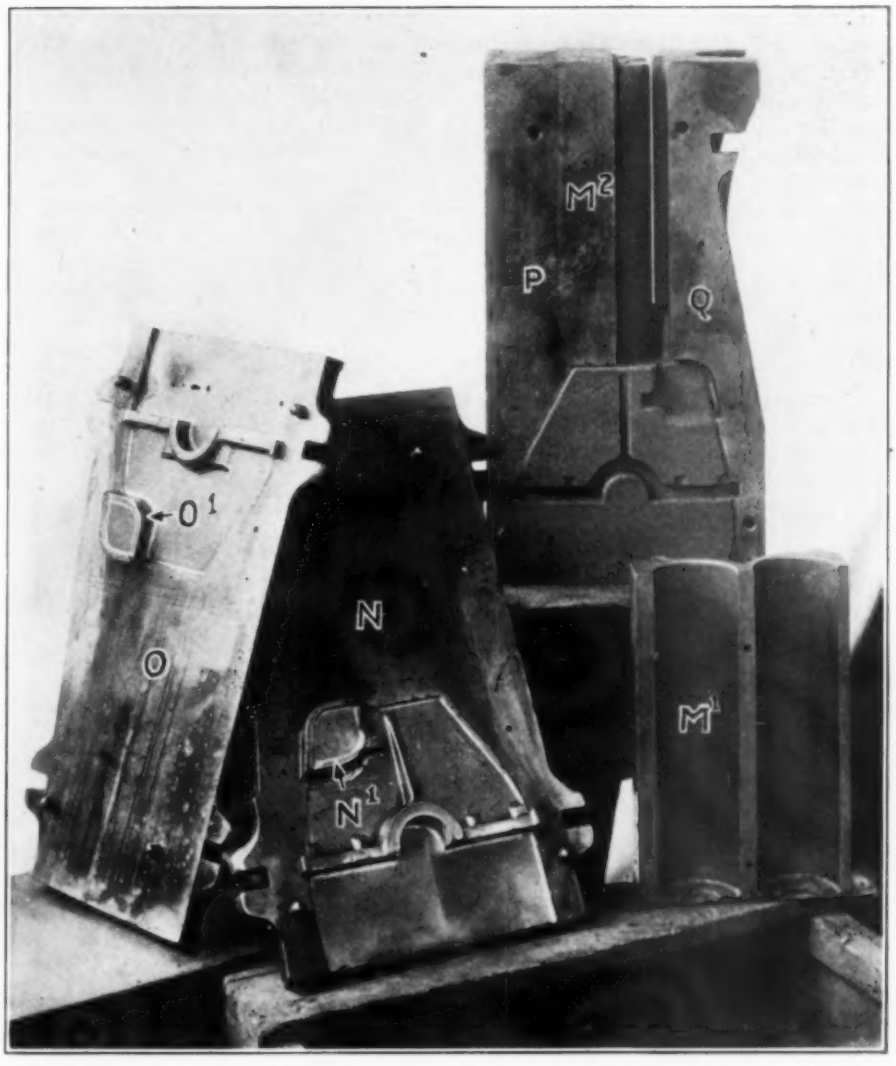


FIG. 4—AFTER THE CORE IS MADE IT IS INVERTED AND THEN THE COREBOX IS TAKEN AWAY IN SECTIONS

the combined body and barrel cores, a full set of cores and a set of cores assembled in a drag, it may be seen that the coring problem is much the same as in the Ford cylinder described in THE FOUNDRY of Oct. 1 and is much simpler, for instance, than the Packard cylinder described in the Feb. 15 and March 1 issues of THE FOUNDRY. The set of cores comprises two half water-jacket cores *I* and *J;* two plain slab cores *EE* which are rammed up at the ends of the square print to reinforce the edges as shown at *E* in Fig. 1; the gate core *G* whose position is shown at *G* in Fig. 1; the two end cores *K* and *L* which form flanges around the two ends of the cylinder block, and brackets supporting the main bearing at each end; the two barrel core units *H*, shown in side and in end view; and finally the runner core *F* which is placed in the end of the pouring basin and serves as a skimmer.

The coreboxes are made of cast iron and as is usual in coreboxes for automotive castings are machined accurately so that no fitting or filing is necessary on the cores before they are placed in the mold. This feature works out to advantage not only in the foundry but later in the machine shop where jigs of various kinds are extensively used in setting up and machining the castings. Separate coreboxes are provided for the upper and lower halves of the water jacket core. This construction is necessary on account of the projecting body of sand at the right hand end which forms the pump chamber. This part of the core is considerably off center and to match the two halves when one is superimposed upon the other it is apparent that one right hand and one left hand core are required. A few other minor features including gaps along the upper edge of the core, the upper edge, of course, having reference to the position of the casting when in operating position, and the lug core *Y*, Fig. 5, also are right and left hand. If only one or two castings were required a corebox with loose pieces could be provided which alternately could be adjusted either for right or left hand; but where cores are required

in large quantities an individual corebox for each half is the logical arrangement. A right hand corebox definitely will produce a right hand core and a left hand corebox just as definitely will produce a left hand core, but where loose pieces are shifted back and forth it is not uncommon to find that some one slips occasionally and some of the right hand cores may have one or two left hand features incorporated in their shapes.

Wax Vents

Two horizontal vent rods extend from end to end of the water jacket corebox. They project through the shell of the corebox and are pulled out after the core has been rolled over on a form which supports the arches. Two upright vent wires at each end and two in the center dividing ridge of sand are arranged to come in line with the horizontal wires. After the core is dried, two shallow channels are filed on the outside of the curved ends connecting the ends of the horizontal vents with the upright vents leading to the joint of the core. Pieces of wax vent are bedded in the channels after which a little core sand is slicked over the wax and then the core is placed back in the oven for a short time, or until the wax has melted and left a clear vent from the joint at one end of the core to the joint at the other end. A vent scratched in the joint and leading through the two small core prints at one end and through the large pump chamber at the other end, forms a channel for the escape of the gas through the joint of the mold.

The barrel cores as they appear, both before and after drying, are shown in Fig. 5, and as they appear when assembled in the drag in Fig. 6. They are made on end in the corebox illustrated in Fig. 4.

Poured from the Bottom

The same features responsible for supplying two coreboxes for the water jacket also apply to the barrel and body cores. The right and left hand core practically are alike but a few minor features, for instance the brackets *O*1 and *N*1, Fig. 4, are not alike, and

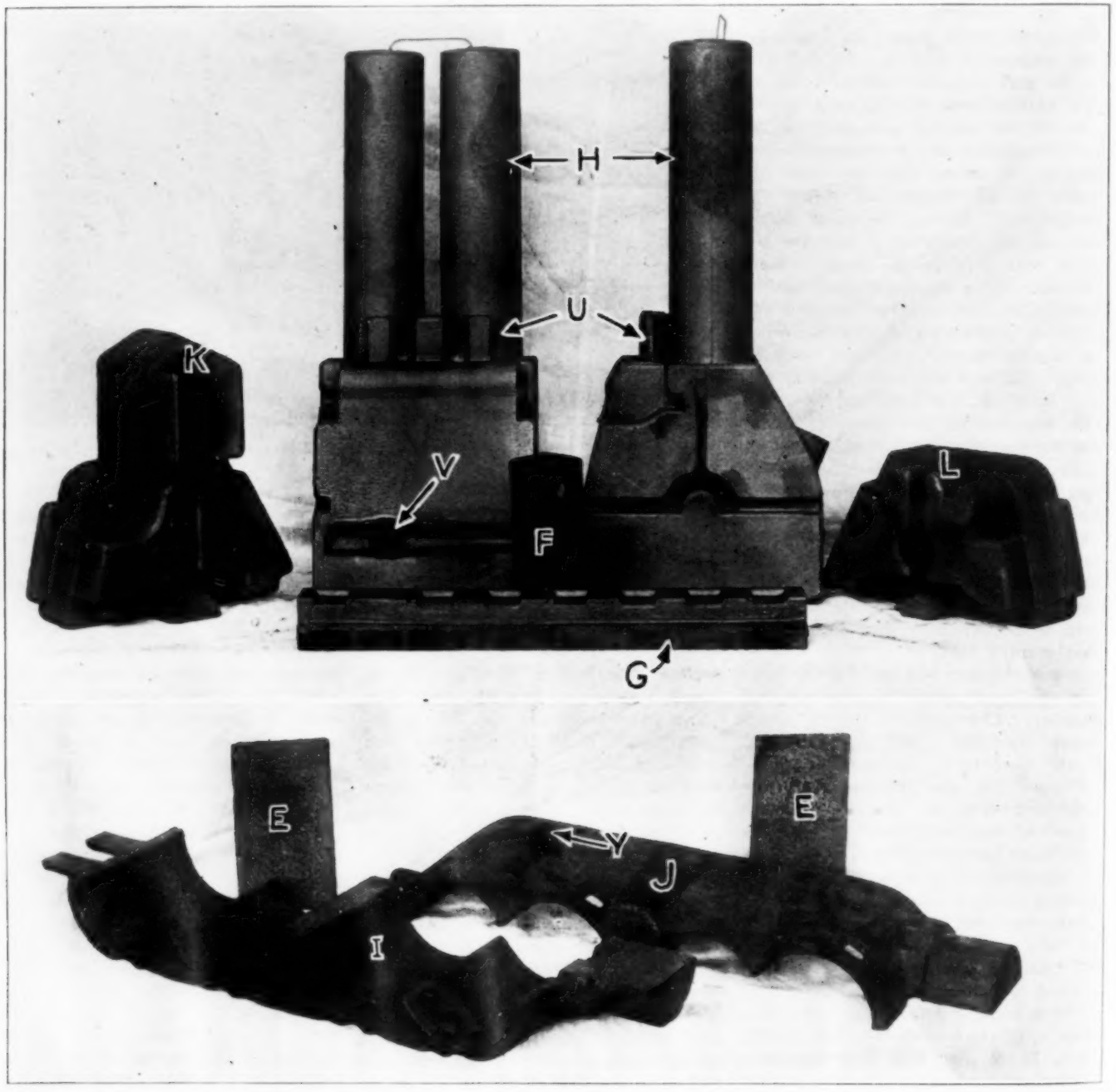


FIG. 5—A COMPLETE SET OF CORES FOR A CHEVROLET CYLINDER BLOCK INCLUDING THE RUNNER CORE *F*, THE GATE CORE *G*, AND THE TWO SLAB CORES *E* USED FOR REINFORCING THE SIDES OF THE CORE PRINT

the pocket for the oil hole at *W*, Fig. 6, only appears on the right hand core.

The construction of the corebox is indicated clearly in Fig. 4. It is made up of a front and back *P* and *Q*, right and left side plates *O* and *N* and two center pieces *M*1 and *M*2 which form the barrels. The box is assembled and bound together firmly by four straight bolts which rest in the slots provided for that purpose in the side plates *O* and *N*. The box is inverted on the bench so that the barrel ends are down and then a piece of perforated 2-inch pipe the full depth of the corebox is adjusted centrally in each barrel by means of a shallow recess in the bottom of the corebox.

A suitable block attached to the corebox near the square, or open end, and on the side which will rest in the drag of the mold, forms a long runner channel. A round plug rammed up in the left hand box, and pulled out before the box is removed from the core, forms a gate opening through the core connecting with the runner on the bottom as shown at *V* Fig. 5. The iron from the runner enters the mold through a number of small flat gates in the core *G*, which as already stated forms the inner and lower edge of the body core print. This core is shown in position in Fig. 1. To prevent the barrel cores from sagging while green a small piece of fairly stiff wire bent in the shape of a capital letter *U* is inserted, points down, into the pipe openings in the top of the core. After the core is rammed, the box is rolled over on a flat iron plate where the bolts are removed and the different parts of the box taken away and reassembled for the following core. The side plates are taken away first, then the pieces that form the barrels, *M*1 and *M*2, are lifted straight up, guided by suitable slides provided for that purpose. This style of construction is not absolutely necessary in the case of *M*2, it merely is a convenience, but on account of the lightening pockets shown at *U*, Fig. 5, it is essential that this part of the box, *M*1, be made separate from the remainder.

The cores *K* and *L*, Fig. 5, beyond the fact that they must be accurate and smooth, present no particular points of interest or anything to differentiate them from the ordinary run of flat back cores made in a one-piece corebox. They are made from a mixture containing 14 buckets of sharp sand, 6 buckets of bank sand, 5 quarts of oil and 1½ quarts of dry core compound. The same mixture is used in the body part of the barrel cores, but the barrels themselves are made from the mixture used in the water jacket cores, which follows: 20 buckets of sharp sand, 1 quart of dry core compound and 4 quarts of oil. The cores are sprayed with blacking before they are placed in the oven.

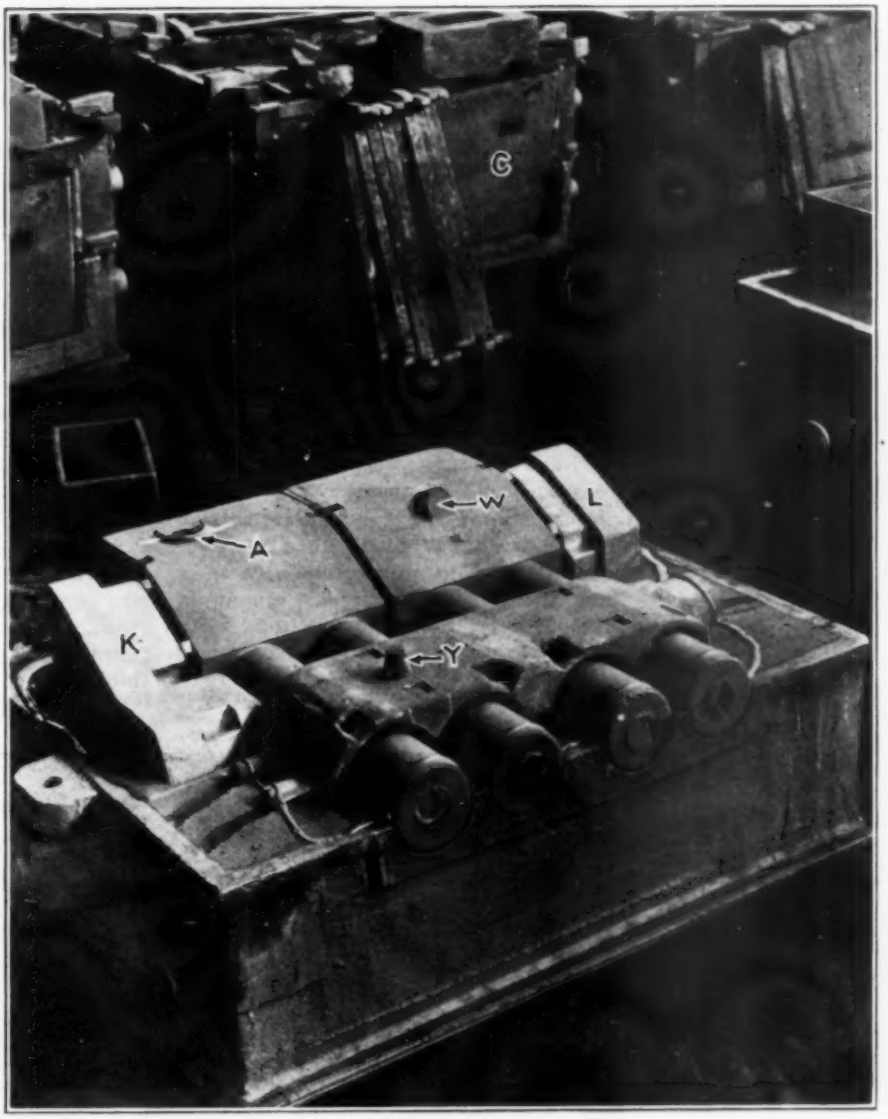


FIG. 6—A CYLINDER MOLD WITH ALL THE CORES SET READY FOR THE COPE—THE WATER-JACKET CORE IS PASTED AND DRIED BEFORE IT IS PLACED IN THE MOLD

In assembling the mold the jacket core is set first, not the lower half but the entire core. It is essential that the water chamber should be continuous, and if the core was placed in the mold in two parts the chances would be in favor of the iron working into the joint in the shape of a thin fin that later would interfere with the circulation of the cooling water. A more imminent danger would be that the iron would get into the vents and produce a blown casting. After the two halves of the water jacket core are dried they are taken from the oven and laid on a bench where they are matched and gaged. They then are pasted and placed back in the oven until the paste has dried.

The barrel core block is lowered until the barrels are level with the opening in the jacket core. It then is advanced horizontally until the ends of the barrel cores come to rest in the core prints. This method of setting the body cores explains the advisability of reinforcing the edge of the rectangular print in the drag with dry-sand cores as shown at *E* and *G*, Fig. 1. After the two end cores *K* and *L*, Fig. 5, are set and held in place by a couple of perforated chaplets as shown in the illustration, a light dough *worm* is laid all around the joint with the exception of the rectangular opening at the back. No chaplets are employed to hold down the water jacket core. The prints at the ends and the two plug cores prevent it from lifting under the pressure of the molten iron. One of these plug cores is shown at *V*, Fig. 6, and the other is shown at *S*, Fig. 2. The first forms an integral part of the water jacket core, and the second is made separately and fastened in the cope. The holes left by these plug cores serve as a convenience in clean-

(*Concluded on page* 579)

Thomas Devlin, Veteran Foundryman, Is Dead

THOMAS Devlin died at his home in Janney, Pa., on June 23 at the advanced age of 84. In addition to numerous positions of importance and responsibility he occupied, Mr. Devlin held the office of president of the company in which he had made his initial start in business life 68 years before as an office boy for the salary of $1.50 a week. He was born in Ireland March 30, 1838, son of William and Mary (Sherry) Devlin and with his parents, three brothers and two sisters migrated to America in 1854 where the family took up its permanent home in Philadelphia. In January 1855 the works at that time known as Thomas R. Wood & Co., and later as the Philadelphia Hardware Co., were purchased by E. Hall Ogden who in 1866 admitted young Devlin and two other employes as members of the firm. In 1871 the three new partners bought out the business and renamed the firm Carr, Crawley & Devlin Co. In 1880 he withdrew from the company and in partnership with Louis J. McGrath started a foundry at Third and Lehigh Avenue, Philadelphia and a still more extensive plant at Burlington, N. J., for the manufacture of steam, gas, plumbers supplies and various side lines. Mr. Devlin was elected president and continued as its directing and executive head until his death. For many years he has been recognized as an authority on every feature connected with the manufacture of malleable iron products. In 1892 Thomas Devlin & Co. purchased the Carr & Crawley works from which Mr. Devlin had withdrawn in 1880. It was renamed the Philadelphia Hardware Co., and was owned principally by Thomas Devlin and Louis J. McGrath, with Mr. Devlin as president.

Shortly after purchasing the old plant, the company, at Mr. Devlin's suggestion, placed a system in force by which employes were given the earnings from $1000 worth of stock for a term of five years on condition that they rendered faithful and continuous service for that period and that they contributed $2 a week toward the purchase of the stock. Many employes have taken advantage of the offer and in addition have acquired further blocks of stock on correspondingly favorable terms.

Mr. Devlin was president of the Thomas Devlin Mfg. Co.; the Philadelphia Hardware and Malleable Iron Works and the National Specialty Mfg. Co., and in addition served as director, or member, of many industrial, financial, social, educational, scientific and technical associations. In foundry associations he probably established a record in that he was president of the Philadelphia Foundrymen's association for more than 25 years. He was a director of the Continental Equitable Trust Co., the People's National Fire Insurance Co., the Bank of Commerce, the Beneficial Savings Fund. He was a member of the Philadelphia and National Chamber of Commerce; the Hardware Merchants and Manufacturer's association, the Manufacturer's Club, the National Founders association, the American Foundrymen's association, the National Civic Federation and several other associations. On January 2, 1866, Mr. Devlin married Helen Amelia Sanford, daughter of Abel and Caroline (Tobey) Sanford, New Bedford, Mass. Eleven children were born of whom eight survive.

THOMAS DEVLIN

Gas Absorption and Oxidation

Defects in Nonferrous Metals Caused by Gas Absorption Often Erroneously Attributed to Oxidation—Defective Metal Brought Back to Normal by Proper Melting Practice—Oxides of Low Gravity Remain in Metal

BY B. WOYSKI and JOHN W. BOECK

MANY writers, in discussing defects caused by oxidation and gassing of bronzes and red brasses advocate substantially the same cure for both. But from its nature, oxidation cannot take place if there is an excess of fuel in the furnace, while the gases absorbed by some alloys are products of incomplete combustion of fuel. Hence the metal can be either oxidized or gassed, but it is

FIG. 1—LONGITUDINAL SECTION OF RISER OF A LARGE CASTING, SHOWING EXUDATION OF TIN-RICH ALLOY

doubtful whether these actions can take place simultaneously.

Oxidation can be easily overcome by the use of deoxidizers or it may be avoided by protecting the molten metal with suitable fluxes. Absorption of gases is more difficult to overcome. The regulation of the air and fuel, so as to produce complete combustion, and the protection of the bath by mineral fluxes are the most important factors. Gas expulsion, resulting in gas holes, porosity, unsoundness, and swollen or cauliflower-headed risers, is said to have several causes. One writer* lists the most common causes in the order of their importance, as follows: Superheated metal, dirty or slaggy furnace conditions, using metals low in quality or those previously subjected to bad melting practice, poor grade of fuel, use of newly lined or damp ladles, indiscriminate mixing of scrap or illogical combinations of metal.

Superheating the metal usually occurs when the heat is ready to be poured but for some reason must be held in the furnace. In this case, a careful furnace tender tries to avoid overheating the metal by keeping a mild fire; that is, a reducing fire which, unfortunately, results in gassing the metal.

A dirty-slaggy furnace may result in gassing the metal by retarding the heating and prolonging the time necessary to bring the metal to the proper temperature, thereby increasing the chances of gassing in uncertain furnace atmosphere.

It is doubtful whether metals of low quality have anything to do with gassing molten metal, except, possibly in the case of metals containing sulphur. The sulphur may produce gas holes as a result of a reaction with occluded oxides. The reaction between sulphur and copper oxide is reversible, depending on pressure and temperature.

Restored by Furnace Practice

Metal that has been subjected to bad melting practice, whether oxidized or gassed, can be brought back to normal conditions by proper furnace practice. In the case of oxidized metal, a deoxidizer or a flux is necessary. In the case of gassed metal, a strongly oxidizing furnace atmosphere of relatively high temperature, so as to produce quick melting, will correct the gassed condition. This has been proved many times. In one case, when, on account of a change in the furnace tender, several heats of red brass were gassed, all the castings were returned to the furnace and melted under the conditions just described, the resulting casting were entirely satisfactory, both as to fracture and microscopical characteristics.

The use of newly lined and damp ladles may be one cause of gassing. This may be ascribed to hydrogen, from dissociated steam, being absorbed and then liberated on freezing, or after action on the occluded oxides with the formation of steam at lower temperatures; however, the dissociation of steam at the pouring temperature of bronzes is negligible.

Indiscriminate mixing of scrap and the illogical combination of metals should never occur in any foundry, but we hardly believe that it would result in gassed metal.

The most important cause of gassed metal is the atmosphere of the furnace. With the proper regulation of air and

FIG. 2—LONGITUDINAL SECTION OF RISER OF A MEDIUM SIZE CASTING

fuel, it will not take place in the case of most nonferrous alloys. Unfortunately, the appearance of the flame outside the furnace is not a positive indication that the right condition exists inside the furnace, especially in the case of open-flame furnaces. The burners should allow intimate mixing of the air and fuel before they reach the furnace; otherwise, soluble fuel vapors may play on the surface of the molten metal.

The appearance of a casting poured from gassed metal depends much on its form and size, nature of the alloy, and the pouring temperature. In the case of red brasses, the riser may not *go down* at all, or it may go down considerably and then, at a lower temperature *come up*. The casting may show gas holes under the riser, which will be different from shrink holes, or it may be solid under the riser but will not machine smooth and the fracture will be discolored. In the latter case, almost any foundryman will pronounce it oxidized. In the case of thin sections of zinc bronze, the casting may machine smooth but, if fractured, will show two layers that are easily separated; this condition also is often ascribed to oxidation. We have heard that this last condition may be overcome by hot pouring; this would indicate that the defect is a

Paper presented at the meeting of the American Institute of Mining and Metallurgical Engineers held in Rochester, N. Y., in conjunction with the American Foundrymen's association, June 5 to 9. The authors, B. Woyski and John W. Boeck are chief metallurgist and assistant metallurgist, respectively, the Lumen Bearing Co., Buffalo.

*R. R. Clarke, THE FOUNDRY (1919), 47, 121.

result of shrinkage due to cold pouring but it does not disprove that the defect is not caused by gases absorbed by the metal, because to get the metal very hot it is necessary to use a hot (in other words, an oxidizing) fire, resulting in quick melting with a minimum chance for gassing.

Not Due to Oxidation

We have strong evidence that the discolored fracture is not always due to oxidation. While making bearings of leaded gun metal, it was noticed that the castings showed discolored fractures. The metal was melted in a Detroit arc furnace, sealed air tight, so that any oxygen inside the furnace was used rapidly by the electrode with the formation of carbon monoxide; the oxidation of the metal under these conditions was inconceivable. The addition of phosphorus, magnesium, mineral fluxes, and charcoal did not help. The same alloy, melted in the Bailey electric-resistance furnace, when poured into the same kind of molds made by the same molder, produced castings of normal fracture. The Bailey furnace is not air tight. There is an inflow of air at the bottom, through the spout under the door, and an outflow of gases and zinc vapors at the top. If the alloy melted is of high zinc content, the pressure of the zinc vapors within the furnace is sufficient to prevent the inflow of air. Thus, in the Bailey furnace there is a greater opportunity for the oxidation of alloys of low zinc content than in the Detroit arc furnace; consequently, we attributed the trouble to the absorption of carbon monoxide, which exists, in a sealed arc furnace, under pressure. The vent was then left open and the trouble disappeared; castings exhibited a clean normal fracture. Later, another user of the Detroit arc furnace stated that if the furnace is air tight during melting, trouble will be experienced. The nature of the trouble was not explained, but it cannot be supposed to be oxidation.

It was also noticed on several occasions that discolored fractures appeared in bearings poured with metal melted in open-flame furnaces with decidedly reducing flames. With a decidedly oxidizing flame and a mineral-flux protection, castings of the same metal had normal fractures.

The so-called tin sweat, or the exudation of a tin-rich alloy from bronze castings also is due to the liberation of gas absorbed in the furnace. This often happened in the past, but does not occur in our practice, since the detrimental effect of a reducing fire was realized. The tin sweat occurs most frequently in the riser. This may go down at first and then when almost solid an exudation takes place, either in the cavity of the riser, or at its edge, if the riser did not go down at all. Fig. 1 illustrates the first case and Fig. 2 the second. Fig. 1 represents a longitudinal section of the riser of a large casting containing 88 per cent copper, 5.5 per cent tin, 1 per cent lead, and 5.5 per cent zinc. The gray material is the tin-rich alloy and the black spots gas holes. In this case the evolution of a combustible gas, taking fire in the cavity of the riser on contact with the air, was seen plainly in partial darkness. Fig. 2 is also a longitudinal section of the riser of a medium sized casting containing 84 per cent copper and 16 per cent tin.

In the case of aluminum bronze, various metallic deoxidizers are used to insure a sound casting. Their use seems to be illogical. Defects in aluminum bronze are caused by gas holes or alumina inclusions. It is well known that alumina forms while pouring, and in the mold if there is any agitation. No deoxidizer will have the opportunity to reduce the alumina formed in the mold; if it does, the product of deoxidation, whether it be a gas or a solid, will be trapped under the skin of the casting.

The amount of oxidation of aluminum bronze while melting is negligible and only on the surface. Any oxide stirred in the metal during mixing rises to the surface readily. This has been proved by melting aluminum bronze in a crucible holding about 3 pounds, stirring the oxides into the molten metal, and then allowing the metal to freeze fairly rapidly in the pot. The button was cut vertically and a section polished. On examination, under the microscope, no alumina was found in the metal except immediately under the top surface. A number of heats of aluminum bronze were poured in this foundry without any deoxidizer, and those castings where there was no agitation of the metal in the mold were free from alumina. All those in which, on account of the design or method of gating, the metal was agitated while filling the mold, invariably, on machining, showed the presence of alumina immediately under the top surface. But the use of deoxidizers in the manufacture of aluminum bronze is quite common, probably because some of them act to a certain extent as degasifiers.

Does Not Remove Gas

Aluminum bronze is very susceptible to gassing; that is, the copper which is melted first is, of course, highly susceptible, and the addition of the aluminum has not a corrective influence; but the resulting alloy is less sensitive to gasification than pure copper itself. When gassed, this alloy poured in a sand mold will not go down in the riser and the casting will show pear-shaped and elongated holes. Aluminum does not remove the gases absorbed by copper. This was also observed by Moore and Beckinsale. That the gases absorbed by this alloy are combustible, and most likely hydrocarbons or carbon monoxide, was indicated in a few cases where the riser was watched and minute bubbles of gas were seen to emerge from the still liquid metal and take fire. By using a decidedly oxidizing flame in oil furnaces, the gassing of aluminum bronze is avoided completely. In coke-fired furnaces, gassing of this alloy never happens, as the atmosphere is rarely, if ever, reducing but probably almost neutral or slightly oxidizing.

Gas Kept in Solution

That Carpenter and Elam* have not found any appreciable difference in the volume of gases from sound and unsound castings, does not prove that blowholes and porosity in unsound castings cannot be ascribed to the larger volume of gas dissolved by the metal. The explanation for not finding very much difference may be that, since gas that cannot be held by the solidifying metal results in gas cavities and films between the crystals, it is removed from the metal while evacuating the furnace tube prior to heating. Unsound castings, being leaky, cannot hold gases that are not in solution, not only when in a vacuum but even under atmospheric pressure. On account of the high diffusibility of gases at high temperatures, much of the dissolved gases is replaced by air right after the solidification of the metal. The amount of gas kept in solution would then be the same in sound and unsound metal. This also may explain the discolored fracture of unoxidized but gassed metal. The air diffused in hot unsound metal would naturally discolor the walls of the cavities.

It is not clearly understood what kind of gases cause molten copper to come up in the sprue and riser, when poured in a sand mold. As a rule, to prevent that and obtain a sound casting, a deoxidizer is used, although it is evident that gases and not oxides are directly responsible for the trouble. The question arises: Is it a gas absorbed in the furnace which is soluble in liquid copper and insoluble or less soluble in solid copper; or, is it a gas which is soluble in solid as well as in liquid copper, and only after reaction with the oxides present in the metal or formed during pouring, is changed to insoluble? In the first case, the use of a deoxidizer is useless, except where the metallic deoxidizer—by alloying with the copper—renders it a nonsolvent for the gas while in a liquid state. In the second case, the use of a deoxidizer is logical. That the gases soluble in copper are not only hydrocarbons is evident from the fact that even in an electric arc furnace the copper absorbs a gas, which could be nothing else but carbon monoxide.

The unreliability of the results obtained on the solubility of gases in copper, by

*Journal Institute of Metals (1921), 25, 219.

*Journal Institute of Metals (1918), 19, 155.

the various investigators, is illustrated by the statement of Bamford and Ballard* in a survey of the literature on this subject that, "the question as to whether nitrogen, carbon monoxide and carbon dioxide are soluble in copper is answered in the affirmative and in the negative by equally strong schools of thought." All investigators agree that the solubility of hydrogen in liquid copper is considerable.

Oxidizing Condition

It may be contrary to the general opinion, but we believe an oxidizing condition in the furnace is less troublesome than a reducing, provided the bath is protected with a thin layer of mineral flux; also that it is more economical in time and fuel. The loss of metal is not appreciably greater. The mineral fluxes protect the surface of the metal and may replace deoxidizers in many cases, but to be certain of the removal of oxides, formed before the metal is meltetd, the metal must be stirred in order to bring the oxides into contact with the flux, because all of the oxides do not float. Aluminum oxide cannot be expected to float in molten aluminum, its specific gravity, 3.73-3.99, being greater than that of aluminum, 2.6. Lead oxide, with a specific gravity of 9.2-9.5, cannot float in any bronze or copper-lead alloy up to 26 per cent lead. Tin oxide, having a specific gravity of 6.6-6.9, floats to the surface of all bronzes, but not as readily as zinc oxide, the specific gravity of which is 5.78.

Two small pots of copper-lead alloy (90 per cent copper, 10 per cent lead) were melted side by side in a gas-fired furnace and the metal badly oxidized; the metal was stirred often in order to mix the oxides formed; then one pot was fluxed with a mineral flux and both were left in the furnace to cool slowly. Both buttons were cut vertically and one half of each was machined and polished, the other half being fractured. The fluxed metal did not show any trace of oxide, while a red powder collected on the tool when machining the unfluxed one. Sufficient of this powder was collected, passed through a 200-mesh sieve to remove minute particles of metal, analyzed, and was found to contain 0.8 per cent silicon, 52.9 per cent copper, 30.9 per cent lead. Nothing else could be detected, so the silicon, copper and lead were calculated to oxides with the result: CuO 66.1 per cent, PbO 33 per cent, SiO_2 1.7 per cent. The machined unpolished section, when examined under the microscope at low power, exhibited holes and fissures from which red powder could be picked. After polishing, no oxide could be detected nor could the oxide cavities be distinguished from the lead. The fracture of the fluxed metal was clean and of normal color; the fracture of the unfluxed metal was discolored, but examination under a binocular microscope failed to reveal any oxide pockets in the fracture. After a long search some gray globules, which seemed to be lead, were touched with a pin and found to be red powder balls enveloped with a gray skin. Further examination revealed large numbers of them, which could be detached from the metal without bursting the skin.

In similar experiments with copper-tin alloys, it was found that with slow cooling, the tin oxide floats to the surface in the form of crystals, the slower the cooling the larger the crystals. Theoretically, the tin oxide cannot exist in the presence of zinc, but in a number of cases we found tin-oxide crystals in red brasses. It is identified by its color, behavior with etching reagents, and its crystalline form. Zinc oxide is infusible at the temperature of molten bronze, and, therefore, could not attain crystalline form; evidently the reaction between tin oxide and zinc is not quantitative.

Floats on Surface

Our experience with monel metal is insignificant, but the detrimental effect of reducing fire on it was also noticed. We tried to follow the instructions of the monel metal manufacturers, but obtained indifferent results. They state that oxidation must be avoided, but we find that sound castings can be made only by avoiding both oxidation and gassing. This can be accomplished by melting in an oxidizing atmosphere and protecting the metal with a mineral flux.

The three common causes of defects in a brass foundry, oxidation, gassing and shrinkage, may produce effects very similar; consequently, the latter two are often erroneously taken for oxidation. The effect, that is the discolored fracture, in every case is due to oxygen; directly, when the metal is oxidized in the furnace, and indirectly, in the case of gas or shrinkage. Gas and shrinkage cause porous metal and intercrystalline fissures, so that air is admitted, which results in the formation of oxide films on the walls of the cavities and fissures.

Discolored Fracture

On the other hand, the normal color of fracture is not a positive indication of the absence of oxides. Even in the same casting, the fracture is discolored at one point and normal at some other; while under the microscope any part of the casting exhibits the same unsound condition and presence of oxides. This was observed in solid bars from 1 to 3 inches in diameter and 12 inches long. The bars were gated into the riser located at one end. The fracture one-third distance from the riser was discolored and the fracture two-thirds the distance from the riser was normal. The polished cross sections cut near fractures exhibited, under microscope, the same quantity of oxide crystals and films. No explanation has been found for this lack of correlation between the appearance of fracture and of polished section.

From these practical observations it can be concluded that:

The most important cause of gassing molten metal is the furnace atmosphere. Gassed metal can be brought back to normal condition by remelting in an oxidizing atmosphere. A reducing atmosphere is more troublesome than an oxidizing one. Defects caused by gas or shrinkage may have a similar appearance to those caused by oxidation and are often mistaken for such by the inexperienced foundryman.

*Journal Institute of Metals (1920), 24, 156.

How and Why in Brass Founding

By Charles Vickers

Trouble with Zinc Base Die Casting Alloy

We are experiencing considerable trouble in producing a die-cast article weighing about 6 ounces and requiring a non-shrinkable metal of some tensile strength. We have used a mixture of 7.5 pounds zinc, 1 pound tin, and 3 ounces lead, which proved very brittle and of no tensile strength, whatever. We will appreciate receiving from you a mixture of higher tensile strength which can be cast in dies.

An alloy frequently used for making die-cast articles consists of lead, 87 per cent, and antimony 13 per cent. Possibly this alloy would be more suitable than the one now in use. An alloy with a zinc base could not be expected to possess much ductility, although it will show some tensile strength when pulled in a testing machine.

The proportions of the alloy in percent-

ages follow: zinc, 86.33 per cent; lead, 2.16 per cent, and tin, 11.51 per cent. If an alloy with a zinc base is preferred the following will be satisfactory.

Die-Casting Alloy

	Per cent
Zinc	85.00
Tin	10.00
Copper	3.00
Aluminum	2.00

If a non-shrinkable alloy has to be used it will be necessary to make a mixture of 50 per cent zinc and 50 per cent tin.

Metal for Fittings for Coffee Urn

We desire to obtain a formula for a cheap white metal that can be used for fittings for coffee urns and which must not corrode from contact with tannic acid and caffeine. The alloy must not be brittle. We have thought of Monel as being suitable.

Monel metal would probably be quite suitable as it withstands the action of many corrosive substances amongst which may be mentioned, water, steam, salt and mercury, also of heat up to 1000 degrees Fahr. It will withstand such acids as citric, benzoic, hydrochloric, dilute phosphoric, salicylic, tannic, hydrocyanic and fruit and fatty acids, also foods except tomatoes and clams. Pure alkalies attack it only slightly.

The various acids in coffee should have no effect on such a metal. As far as the corrosive action of coffee is concerned, pure tin has been used for years experimentally in contact with coffee without the least sign of corrosion, and there is little doubt but that Britannia metal would withstand this fluid and leave little to be desired.

If a German silver is wanted the following is about as cheap as can be made, and not have any lead content, which in this particular case would not be advisable.

Victor Metal

	Pounds
Copper	50
Nickel	15
Zinc	35

Flux with 2 ounces aluminum.

Thick Coat of Plumbago to Protect Cores

We have experienced trouble with brass eating into cores, and wish to learn of any core wash that would prevent this. We are using an alloy of 85 per cent copper and 5 per cent each of tin, lead, and zinc, and we add to this a 25 per cent addition of ingot containing copper, 90 per cent; tin 10 per cent. We do not see why such a mixture should burn into the castings, but would like to have your comments, the castings weigh from 2000 to 3000 pounds each.

The foregoing mixture in percentages follows: copper, 86.25 per cent; tin, 6.25 per cent; zinc, 3.75 per cent; lead, 3.75 per cent. This is a very fluid alloy having a relatively low viscosity, therefore, it runs sharp and will penetrate between the grains of sand to a certain extent like water. If the metal is poured hot the degree of penetration will be greater than when poured at a more moderate temperature, as the viscosity decreases with the superheat. If a little aluminum could be added to the alloy it would have great influence in preventing it penetrating the core, because it would increase viscosity. As it is not advisable to add aluminum, the only thing that can be done is to protect the cores; for this purpose a *wash* of plumbago applied with a brush in the ordinary manner is worthless—the plumbago has to be smeared on the core. First, coat it in the usual manner then apply a paste of good plumbago by rubbing on with the hand. Mix the plumbago with some adhesive like molasses, and apply to the dried and warm cores until they are coated like a stove with a polished coat of plumbago. Any thin coating that sinks into the sand of the core is useless. When the plumbago is properly applied with plenty of pressure, it will protect the core from penetration and also will not cause porosity.

Temperature Should Not Exceed Full Red

We would like to learn how hot aluminum and also brass should be to pour light castings. We are new at the business and sometimes get the aluminum too hot with the result that the castings are brittle. We are working on an aluminum solder to be applied with a soldering iron but up to the present have not succeeded in producing any thing satisfactory. Can you give us a formula for an alloy of that character.

Extreme care must be exercised when melting aluminum to prevent it from becoming too hot. If the temperature of the metal does not rise beyond a point indicated to the eye by a full red color, no harm will be done, but if it becomes white hot the aluminum will be burned. It is an easy metal to handle provided care is exercised in the melting. In determining the proper pouring temperature a number of factors must be considered, including the size and metal section thickness of the casting. Each casting has to be sized up with a view of adjusting the pouring temperature of the metal to the lowest point compatible with safety in pouring that particular casting. The correct pouring temperature for any aluminum casting is as cool as it is possible to run it and this point easily can be determined by a few trials with metal at different temperatures. After the correct temperature has been determined it is advisable to use a pyrometer, make a note of the temperature, then all subsequent heats can be poured exactly right and a maximum production of good castings will be the reward. No formula is known for an aluminum solder that can be applied with a soldering point in the same manner as with other metals. The object to be soldered has to be heated, the solder is melted and rubbed on to the surface until it is *tinned*.

One of Many Causes May Be Responsible

We have encountered some difficulty when casting small ornamental castings, two samples of which we send for your inspection. To get a smooth skin on the scrolled face of the casting we print back the patterns, afterward skin-drying the mold with charcoal. The mixture we use is made up of copper, 83.25 per cent; zinc, 12.50 per cent; lead 2.50 per cent, and 1.75 per cent. Can you advise what causes these little holes like specks on the face.

The holes are caused by dust either left in the molds, washed there, or carried in with the metal. The molder making fine work of this character seldom leaves any grains of sand in his mold; usually he blows the impression out perfectly clean with a blowpipe. It may be washed from the gates, and if so, too heavy a coating of flour may cause it. First eliminate both of these probable causes; next if the alloy contains a high percentage of zinc, it may be due to zinc smoke entering the molds. This is avoided by pouring fast enough to keep the heads filled until the mold is filled.

Little specks like the ones in these castings are often found when the crucibles are poured with the side tongs. The lip of the pot is rested on the edge of the iron flask, in which case as the pot is tilted to pour, using the lip as a fulcrum, there will be a little slip which scrapes off a little graphite and this graphite dust is washed into the mold by the stream of metal, and deposited in the castings. The remedy is to hold the pot off the flask, or to widen the sprue away an inch from side of flask, then scoop out a little hollow in the sand near the edge of flask, into which the scrapings may fall and stay. One of the foregoing causes is responsible for the dirt and can be determined by a process of elimination in a very simple manner.

Co-ordinating Foundry Control

How Five Large Castings Manufacturing Plants Solved the Problem of Executive Management Involved by Combining the Direction of General Shop Practice and Research Under One Head

ENOUGH has been said in a previous article regarding some investigations of the Electric Steel Founders' Research Group to show the thoroughness and extreme importance of these in the operating plan. An explanation of the general inspections by the research director may serve to suggest to other steel casting plants a method of systematic scrutiny which has proved of value. The director's duties fulfill the best conception of what is asked of the modern company doctor. He is expected to search out sources of probable future troubles, to prevent them as well as to aid in curing ills which exist. Major Bull makes periodic visits to each plant, preparing reports on them in turn, copies of each of which are sent to all members. He comments upon such items as shop appearance; safety precautions; economy in equipment operation; waste prevention; sand mixing and condition of facing; condition of molds and cores; furnace operation; condition and handling of metal while pouring; effectiveness of annealing and welding; condition of castings when shaken out and when ready to ship; and efficiency and morale of the shop organization. No point which has to do with the welfare of the plant or the quality of its product is omitted intentionally. A typical report which is abstracted on another page serves to give an idea of the painstaking care and diligence shown in these inspections; likewise the frankness with which comments are offered in the knowledge that they will be received in the proper spirit. The names of the plants have been disguised in the abstract appended, which is one chosen at random.

These reports of general inspections have instilled into each organization a spirit of healthy rivalry. They are passed along to metallurgists, melters, foremen, and others in charge of the different lines of work under consideration. Like the frequent but irregular visits of bank examiners, these inspections by Major Bull furnish an incentive and keep the working forces of each shop on its individual and collective toes. The director's recommendations are backed by the full authority of the executive staff in each plant. For example, if he suggests a change in the sand mixture the matter is given immediate attention and the results are checked. The standard of every shop under this system of inspection and report constantly is being brought into line with the best practice that prevails in each other plant of the group.

Critical Observation

The director's inspection of the finished product frequently is more critical than that given by the customer because he has the collective welfare of the entire group to guard. Commercial specifications for steel castings are supplemented by a complete set of inspection standards developed by the group and governing its entire production. These standards in every case are paramount, and selling prices, difficulties in manufacture and other considerations are subordinated in the sincere effort to produce the best steel castings for the purposes required.

The results of the strict application of this practice are evident in many small details as well as in the main phases of foundry practice. For example, except where the customer stipulates a different procedure, all castings are carefully annealed; surface imperfections, even of slight extent caused by dirt or slag, must be chipped out thoroughly before being welded; all cored holes for the application of other parts are carefully cleaned of adhering sand, regardless of whether such surfaces will be machined later; the use of any form of filler for defective cavities or crevices is strictly prohibited; the closest scrutiny is required prior to welding; and except where because of frail design distortion might result, all castings are put through a tumbling barrel to give them a superior finish. The standards further require the manufacture of production jobs to be accompanied by systematic cutting and machining of typical castings to ascertain interior soundness. In effect, the research director acts as a chief inspector, checking up the performance of the inspectors at each plant in their adherence to the rigid standards established by the association. The director is particularly watchful over such matters as the quality and appearance of castings as delivered to the consumer. Realizing that an inferior product shipped by any one plant will detract from the good reputation sought by the collective membership each plant expects the director to point out in a positive manner all details wherein any laxness is shown. A further check on the inspectors is obtained by a report transmitted monthly to the director from each plant showing the castings returned by customers as unsatisfactory,

Steel Foundries Co-operate in Joint Research Work

Scientific Investigations Lead to Better Product—Ideas Are Freely Interchanged

UNDER the preceding title, THE FOUNDRY *in the issue of July 1, presented a synopsis of the history, organization and purposes of the Electric Steel Founders' Research Group. The operation of this group presents such a novel illustration of technical co-operation that the accompanying discussion of the detailed plan, the mechanics of its operation was solicited and prepared with the full assistance of the associated companies. The facts given present an object lesson in industrial management and typify modern reciprocity in technical ideas. The same cordial spirit, based on a willingness to assist others in the foundry business is shown in the offer of the group to make available the results of its research studies. This information will be presented from time to time through articles in* THE FOUNDRY.

the nature of the defects, and the extent to which the inspectors were apparently responsible because of careless examination. The director's criticisms concerning the inspection as conducted at any plant are disseminated to all the other group plants.

It was stated in the forepart of this article that regular reports transmitted to and from the office of the research director constitute an important feature of the group's activities. At the close of each month, the members transmit to the director, among other reports, one showing the tons produced; the tons shipped; the average weight of castings shipped; and the percentages of the following items; good castings to charge; heads and gates to charge; shop defectives to charge; spills and skulls to charge; charge unaccounted for; shop defectives to total castings and return castings to total sales. An interesting feature of this report analyzes the shop defectives as made at each plant monthly, indicated by the six principal causes for bad castings. The percentage for each of these six causes is calculated, illustrating clearly the relative importance of every such cause for

Inspections Cover Infinite Detail

GENERAL INSPECTION OF PLANT X

General Features

THE shop was in a less cleanly condition than any other shop of the group that I have seen lately. Plant *Y* recently conducted a vigorous clean-up campaign with excellent results which they now feel to be reflected in low operating costs. Many parts of your shop were untidy, detracting from the good effect which the condition of your castings alone would produce upon an outsider.

Among the departments open to criticism from this standpoint, your laboratory takes a prominent place, both because of its present condition and because of its location. The accumulation of many old trade journals and of old records and the indifferent care given some of the laboratory equipment indicates an inadequate appreciation of the value of such equipment. The moral effect of this condition is probably felt not alone by visitors but by foremen.

On bright days many electric lights were observed burning to no purpose. This matter can wisely be supervised by a designated person.

Many sections of air hose were leaking, and air hose connections were in bad order. Under present operating conditions the justification that exists when operations are heavy is not present.

Safety precautions were not being carefully observed. Some of those pouring steel were not equipped with leggings and only one workman was wearing goggles. The advisability of ample precautions in these respects has been noted previously. In the passageway near the cleaning room and leading to the stairs to the production office, a hole is noted in the floor which might cause serious accident.

Sand Mixing

Your facing mills are in poor condition as regards the plows, mullers and plates. The condition of some of the plates and mullers is not one that can be remedied frequently like the plows. The latter should have systematic and careful attention by persons specially delegated. The expense of so doing is compensated by the results obtained in the mixtures.

The operator at one mill has been furnished with a bulletin board on which the proportions are indicated for his guidance. The operator of the other mill had no such visible instructions. While the instructions were specific, the mixture specified is *not* the one as recently modified and now intended to be used. Written instructions should be up-to-date.

One core mixture now in use to a considerable extent is stronger than is desirable for some of the work on which this mixture is used. This consists of: Thirty-five shovels of silica sand; 3 quarts of wheat flour; 12 ounces of resin; 2 pints of boiled linseed oil; 1 pint of fuel oil. It is suggested that you ascertain the relative tensile strength of this sand by making some briquettes in the corebox made according to the blueprint sent you.

Metal Preparation

All heats poured under observation of the director were quite hot and quiet, showing no sparkling and cupping satisfactorily. Apparently the gas had a good opportunity to escape and no tendency of any mold to kick was noted. Little slag was observed on the metal in the shank ladles and less than was noted last summer. A poor type of skimmer was used, but the men were using it diligently.

It was interesting to learn that your present furnace lining is made of ganister and the experience you find with this material will be interesting to all of the group members. It is not surprising that you find better results from your new ladle lining mixture consisting of six parts of ganister and one part of clay than you got from your former mixture. The linings have been considerably reduced in thickness, which, of course, lowers the cost.

Condition of Castings as Shaken Out

The sand was peeling well indeed and was blasted off without difficulty. Less dirt and slag appeared in your castings than was the case on a previous inspection. This probably is due to several factors, including a more satisfactory ladle lining, better attention to skimming and less tendency of the facing to cut and wash. The latter, no doubt, is due to a larger proportion of fireclay. Your brake-bands and castings from pattern No. — are much improved in appearance over the previous condition.

Some castings on your cleaning floor were poured with rectangular risers which could have been supplied readily with round risers. The latter are more effective. No shrink holes were found under any risers.

Generally speaking, the gating of your castings seems to have been carefully studied and to give very good results.

Judging alone from the appearance of your castings as they are shaken out of the flasks, thorough attention is not given to venting. Many castings of design that should be vertically vented show no sign of such vents. Every reasonable precaution should be taken regularly to permit the free escape of gas. Plants *Y* and *Z* are undoubtedly much more thorough in their venting practice than is your plant. Because of the nature of the product, your plant has more reason to look to this feature than does any other plant in the group.

Appearance of Castings Ready to Ship

Several holes in castings were anything but clean; in some instances an excessive amount of annealing scale and an occasional large lump which should have been removed were present. Castings were found on the welder bench having dirt and slag spots which had not been thoroughly chipped out previously as required in the inspection standards. These castings were shown to your chief inspector and he was urged to be more careful in this matter. Your staff of inspectors is sufficiently large to give you a more thorough inspection and a more satisfactory adherence to the group inspection standards than was evident.

Despite the criticisms just made a noticeable improvement is being effected in the thorough cleaning of castings in general so that the impression casually formed from a visit to your shipping floor is good. Attention paid to some details pointed out will further improve the situation and will reflect more creditably upon your shop inspection.

Miscellaneous

Never before was so much industry shown on the part of workmen as was noted on this trip. The snappy way in which the men poured the metal was particularly noticeable. This work was well organized, permitting the handling of the metal in a minimum period of time.

The new type of facing skids in use seem to be splendidly adapted for the purpose and might be duplicated at some of the other plants to advantage.

It may be worth while to remind you of a former suggestion that at an appropriate time your large annealer be redesigned to permit more economical handling of the castings. When that idea is developed by your works engineer attention wisely can be given to some means for lessening the excessive labor now entailed in loading the small annealing oven which is not equipped with a truck. A container for the castings annealed in the small oven could be lifted mechanically, thrust into the opening and later withdrawn without entailing a large expenditure for equipment. This work could be performed much more easily when operations are at a reduced stage.

The platform scale installed for weighing the heats was noted with great interest. The use of such a scale is well worth while since the management thereby secures data on losses of metal which make economies easier to effect.

RIGID INSPECTION PRECEDES ANNEALING AND FOLLOWS THE FINAL FINISHING

scrapped castings. When all the data from each plant are assembled, information is distributed from the director's office to the members in summarized form, giving each manager an opportunity to scrutinize the record of his performance in comparison with that of his associates.

Indicates Weaknesses

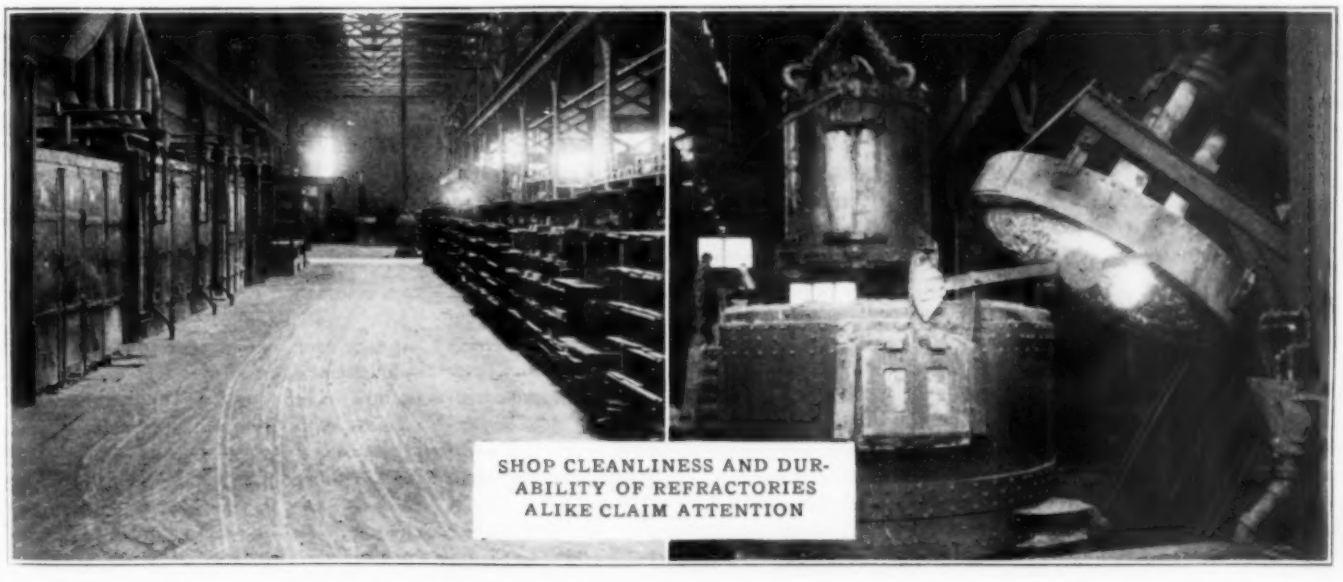
The composite analysis of defective castings is informative, indicating where efforts should be directed to cure the most pronounced evils. In transmitting the summary, the director appends his analysis or review of the report giving his comments covering the different items and the tendencies as they appear. This is done in a constructive manner and in a way to stimulate each organization to more efficient operation.

It will be seen that the report just mentioned refers to general operating conditions. This is supplemented by reports relating exclusively to each of the important operating departments. They are of such detailed nature as to prevent full explanation here. It requires little consideration to realize the value to each member of such information exchanged in a systematic way and presented in summarized form with an expert analysis. The information covering the furnace department shows the percentages of all metals charged and added in the furnace, represented by the weight of each commodity so used; the pounds of electrodes consumed per ton of charge; the average power consumption per ton of charge; the best furnace roof record and the life of the last previous roof; the average melting time per ton of charge; and the consumption of miscellaneous materials used for the furnace department. The molding and core reports cover many important items including the amounts of molding sand, core sand, fire clay and other commodities used per ton of product. The finishing report shows the tonnages cleaned and inventories of the tonnages in the cleaning room and in the shipping room. It also covers in detail the numerous operations of that important department to show the efficiency and economy in such items as welding and annealing. Any welding which may have been done by the consumer must be reported. Economies are suggested in such figures as the quantities of sandblast sand consumed per ton. A check on thorough finishing is made through reporting on this form any outside finishing charges allowed.

Graphic Charts Used

Periodically these monthly reports, which are summaries of the individual reports, are themselves summarized to show performances representative of an extended period for each member and for the group as a whole. Some of these reports are supplemented by graphic charts issued by the director conveying the information in an effective way.

Among the monthly reports submitted from the director is one that affords an interesting index to efficient chemical laboratory operations. This detail has been developed with such thoroughness by the group that an explanation of it may be interesting to some who might find it desirable to follow the same plan. Each member casts from each heat a plate of specified thickness from which clean drillings are taken. Drillings made within ¼-inch of the surface



SHOP CLEANLINESS AND DURABILITY OF REFRACTORIES ALIKE CLAIM ATTENTION

are discarded. Each plant chemist makes routine determinations for the various elements from each plate. The carbon determinations are made by combustion, this method being found to be the most reliable. A record of the complete analysis is filed in the plant manager's office immediately after the plant chemist makes his own determinations, and each analysis plate is identified by the proper heat number and stored until the end of the month. At that time every plant manager selects one plate at random and has six lots of specimen drillings taken which are forwarded to the research director. Through a system of reporting each plant previously has transmitted to the director information as to its own routine analysis on every heat made.

Interchange Samples

When the director receives the six sets of drillings from each plant with information as to the heat number involved, he transmits to each plant laboratory a set of the drillings received from each of the other four plants. Secret key numbers known only to the director are assigned to each sample. Consequently the chemists who receive these drillings have no information permitting them to identify the sample drillings. The director holds two sets of drillings in reserve for possible rechecks or analysis by a commercial laboratory in case of a wide disagreement in results.

Each plant chemist, on analyzing the drillings from the other plants received through the director, makes a report to him which permits the preparation of a composite report showing the probable analyses of all the samples as estimated by the director. Using the probable or composite analyses as a guide the director then compares the original results submitted by each chemist as reported in the routine way and illustrates mathematically how accurately each chemist's work is performed. On the supposition that each set of routine analyses which has been checked in this manner typifies the accuracy of each plant's laboratory, a rank is assigned monthly by the director to each plant for accuracy in chemical analysis. Each plant receives from the director tabulated figures showing the manner in which the probable analyses were ascertained, a detailed report showing how each plant's analyses check with those from each other plant on the same samples, and a review of the month's work as thus typified conveying comments as to tendencies and suggestions as to possible improvement.

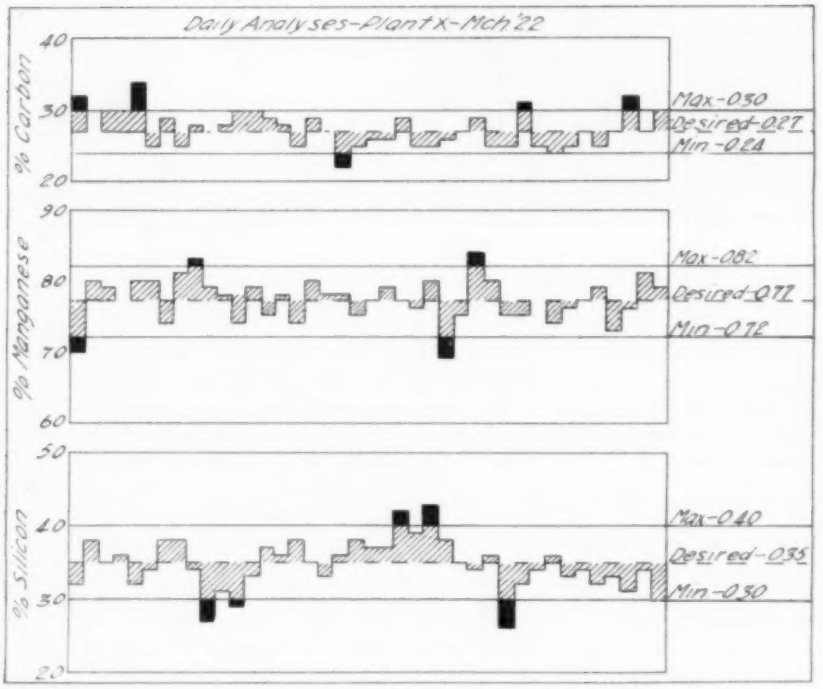
A tabulation prepared to show the manner in which the discrepancies are figured and by which relative rank is ascertained accompanies this article. This tabulation does not illustrate an actual performance and is only typical as to the method described. The effect on the chemists of the regular transmission of such reports to the plant managers is highly stimulating, and produces a healthy rivalry to attain accuracy.

Another report which is forwarded monthly by the director to each plant manager affords a satisfactory method of gaging accuracy of furnace operation from the standpoint of uniform composition of steel. This is described in detail elsewhere. It would not be reliable if measures were not taken as indicated above to verify the accuracy of the work of the chemists.

To one not familiar with the manner in which the various reports and tabulated data are handled, it might seem that a considerable quantity of information would be distributed, scanned in a hasty manner, and put aside without receiving important consideration. This might be possible were it not for the manner adopted for following through to a completion each activity of the Group.

No undertaking is permitted to lapse through lack of interest. The visits and recommendations of the research director backed by the active attention of plant officials who discussed the items in each report with minor executives, is fruitful of immediate results. Frequent conferences are arranged between the principal officials of each company at which careful consideration is given to the im-

How Uniformity Is Checked



EACH foundry reports to the research director giving the results of its chemical analyses made for every heat. From these graphs are prepared monthly, one for each plant, copies being sent to all plants, so that the managers, metallurgists and melters may compare results. Six points variation is allowed between the maximum and minimum for carbon, and 10 points range for manganese and silicon, respectively. The variations from the averages sought are shown by the shaded areas, while the blackened portions indicate divergence outside the permissible ranges. This indicates readily the deviations from the prescribed limits, and permits a rapid calculation of the number of points outside, characterizing unsatisfactory furnace practice. The number of points outside, that is, the number of black areas, are added and divided by the total number of heats reported, giving a method of comparison and checking the composition control in each individual plant. In the carbon graph shown, which is typical as to method only and is not a chart made from actual results, 11 points are shown outside the limits, and the total number of heats is given as 40. The resulting percentage or score is 0.275. The fictitious graph for manganese shows 8 points outside the range and the result is 0.200; while the silicon chart shows 13 points outside with a score of 0.325. This would indicate that the melter showed greater skill in the control of manganese than he did in regulating either carbon or silicon. The tendency to obtain low silicon during the latter part of the period illustrated is clearly shown from the graph.

portant operating phases of the business. The closeness of the technical co-operation of the associated companies permits these conferences to bring to each plant the best judgment on the executives of all of the other firms, resulting practically in securing for each member plant, the abilities of the men in all the different organizations. The effect of the active interest of so many men in all the plants in each activity keeps alive all subjects which are touched upon in each report.

Of course, one of the duties of the director is to keep in touch with all technical matters that relate directly and indirectly to the operation of the member plants. Being free from routine operating duties he naturally can keep in closer contact with outside matters relating technically to the business that can a busy plant manager. Information of value is transmitted from the director to each operating head in considerable volume, apart from the regular and systematic reports. One plant frequently undertakes a research of its own covering some phase of its operations which makes an individual investigation advisable. As a result it frequently happens that an important principle is established at one foundry which can be usefully applied at one or more of the others. The close contact maintained permits information of this nature to be disseminated immediately and fully to all of the associated companies.

Foundry Detail Complicated

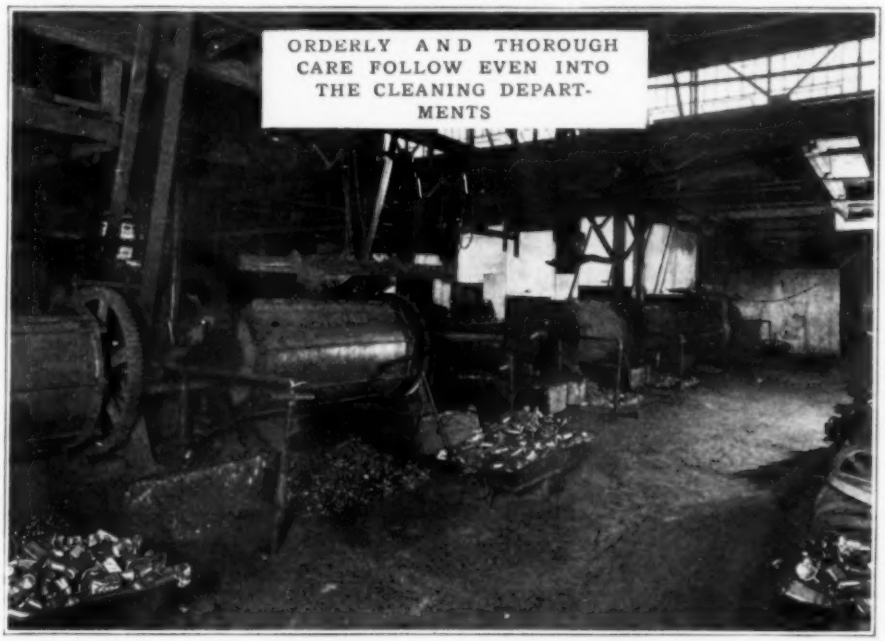
That the manufacture of small steel castings has many complexities will be realized by anyone who has read the foregoing.

The amount of detail involved in all phases of foundry practice is enormous, necessarily causing a considerable expenditure for labor, and requiring the closest scrutiny into the efficiency of each operation in order finally to give the customer a casting of the highest quality. In their efforts to do this, the group foundries have seen the great advantage of technical co-operation, and and constant study of improvement of methods of manufacture, undisturbed to unusual extent by the many conditions arising in the daily routine of operating staffs.

Electric Steel Founders Research Group Meets

Officers and operating officials of plants holding membership in the Electric Steel Founders' Research group held a meeting at East Aurora, N. Y., for several days, immediately following the convention of the American Foundrymen's association.

An extensive description of the co-operative technical plan followed by this research group, which is made up of representatives of the Electric Steel Co., Chicago; Fort Pitt Steel Casting Co., McKeesport, Pa.; Lebanon Steel Foundry, Lebanon, Pa.; Michigan Steel Castings Co., Detroit; and the Sivyer Steel Casting Co., Milwaukee, has been presented in the July 1 and July 15 issues of THE FOUNDRY. At the convention of the American Foundrymen's association the results of comprehensive investigations in testing molding sand were presented by R. J. Doty, Sivyer company, who had been delegated by the group to carry on such a research for its own account. The group made its information on the subject available to the industry at large. The result of this, as announced at the foundrymen's convention, has aroused interest, particularly and further developments are awaited with interest.



ORDERLY AND THOROUGH CARE FOLLOW EVEN INTO THE CLEANING DEPARTMENTS

Safety Council To Meet in Detroit

From Aug. 28 to Sept. 1 the National Safety Council will hold its eleventh annual safety congress at Detroit. From present indications the 1922 convention will be the largest in the history of the organization. The program opens with an address of welcome by Pres. Samuel C. O. Mumfor of the Detroit safety council. The list of speakers includes such well known names as Edgar A. Guest, Detroit Free Press, Detroit, Dr. George W. Crile, Cleveland; R. A. Shaw, Ford Motor Co. Detroit, and many others The railroads of the United States and Canada have co-operated in making special round trip rates to Detroit.

The safety council has realized the importance and need of investigation and improvement of the conditions in the metal trades. For the consideration of these problems a sectional conference will be devoted to this important phase of the work. The officers of the metals section committee are J. R. Mulligan, safety inspector, Bethlehem Steel Co., Bethlehem, Pa., chairman; J. A. Northwood, safety engineer, Cambria Steel Co., Johnstown, Pa., vice-chairman; Walter Hart, safety inspector, Jones & Laughlin Co., Pittsburgh., secretary. The addresses scheduled are as follows: Outstanding Features of the Safety Movement in Iron and Steel, 1910-1919 Dr. L. W. Chaney, U. S. Bureau of Labor Statistics, Washington,; Safety in Electric Furnace Operation, E. T. Moore, electrical engineer, Halcomb Steel Co., Syracuse, N. Y.: The Safe Handling of Gas at the Blast Furnace, and Safety in Crane Repairing.

Casting Chevrolet Cylinders

(*Concluded from page* 569)

ing some of the core sand out of the water jacket chamber. The holes are tapped and plugged before the cylinder is tested. The hole shown at *A*, Fig. 6, is the runner leading to the gate at the bottom of the core and will coincide with the hole, shown at *T* in the cope, Fig. 2, when it is closed down into place.

After the cope is set on, the plate shown at *C*, Fig. 6, and in detail in Fig. 3, is adjusted behind the rectangular opening in the flask and the space between the plate and the ends of the body cores filled with sand which is rammed, but not hard enough to force the cores out of place. No risers are employed, but a ¼-inch rod is forced through the cope at several of the highest points in the mold and eliminates any danger of gas pockets forming at those points.

Success Attends British Show

First International Exhibition of Foundry Equipment and Supplies Affords Opportunity for Technical Comparisons — American Machines Shown—Vital Need for Manpower Reflected in Innovation

BY H. COLE ESTEP
European Manager, THE FOUNDRY

THOROUGHLY representative of the complete development of the British castings industry, the first foundry exhibition ever held in the United Kingdom opened at Bingley Hall, Birmingham, England on Thursday, June 15 and closed June 24. However, the displays were not confined to British products, but included characteristic exhibits by prominent foundry equipment manufacturers and specialists in the United States, France and Belgium, and the visitors to the show came from many parts of Europe and America, as well as from all sections of the British Empire. The official title of the show—International Foundry Trades Exhibition—proved unusually apt.

The exhibition was organized by the Birmingham Chamber of Commerce in conjunction with the British Cast Iron Research association and the Institution of British Foundrymen, and was held in connection with the nineteenth annual conference of the latter organization, which took place in Birmingham, June 21-23.

When the show was opened June 15 by Alderman David Davis, Lord Mayor of Birmingham, 119 exhibits were in place, of which approximately 85 may be said to have been directly connected with the foundry industry. From the technical standpoint, perhaps the chief feature of the exhibition lay in the opportunity which it afforded for comparing various types of molding machines operated by hand and by pneumatic, electric and hydraulic power, the machines being built in various countries on both sides of the Atlantic.

Melting Units Attract

Next in technical interest to the visitors possibly were the different types of melting furnaces and cupola charging devices displayed. Exceedingly instructive exhibits of sand preparing machinery, pig breaking devices, and core oils also were shown.

In general, these exhibits reflected the changes which have taken place in British industry since the war as a result of the relatively high wages now being paid. These changes, plus the loss of manpower in all Europe through the war, have accelerated the trend toward the installation of labor-saving equipment. Nowhere is this trend more unmistakable than in the British foundry industry. In spite of a temporary surplus of labor, British foundrymen are everywhere engaged in overhauling their plants and installing machinery to cope with the demands which it seems will be made for increased production.

The molding machine exhibits reflected the great progress which has been made in the past few years throughout the world in the design and construction of molding devices as the result of the application of engineering principles. Practically all of the machines shown, whether of British, Continental, or American origin, were the result of much thought and effort, and both in design and con-

SOME OF THE HEAVY EXHIBITS AT THE INTERNATIONAL FOUNDRY TRADES EXHIBITION

struction they possessed a refinement which a few years ago could have been found only in machine tools. Furthermore, it is believed that at least two of the machines at the British exhibition embodied new principles in the application of power. In one case machines were shown combining the use of electricity and compressed air in one unit, while another exhibitor showed what is believed to be the first hydraulically operated jar-ramming machine. Still another exhibitor showed what is claimed to be the first hand-operated, roll-over, jar-ramming machine. The influence of modern engineering on the details of its standard machines the Adaptable company also showed a hand, roll-over, duplex machine with a 12-inch draft, the load being rolled over on its center of gravity and automatically locked. This machine is specially suitable for core molding and also may be used for match-plate work. Duplex sand sifters similar to those already described in THE FOUNDRY were displayed, together with many other types of foundry equipment, including two sizes of single and double reel centrifugal sand mixers built by Brearley & Co., Sheffield. The Adaptable company has been made sole agents for the Brearley products. In two plungers or pistons. The table falls back when the air is exhausted by uncovering a port at the top of the stroke. The pattern drawing mechanism is gear operated, the whole machine being controlled by a single lever. A new pneumatic device for controlling the intensity of jar has recently been developed for these machines. It consists simply of a by-pass controlled by a valve. As the valve is closed, the intensity of the jar increases and it is said the action of the machine may readily be varied from a mere flutter to full intensity.

With suitable labor it is said that it is possible to obtain up to 200

THE PRODUCTS OF HALF A DOZEN COUNTRIES WERE SHOWN AT THE BRITISH FOUNDRY EXHIBITION

many of the standard machines was reflected in the use of renewable bushings, improved lubricating and dust protecting devices, along with the general simplification of design and construction.

The hand-operated roll-over jar-ramming machine mentioned above was exhibited by the Adaptable Moulding Machine Co., Birmingham, England. The jolt table of this machine is actuated by a cam mechanism geared to a hand wheel, and one man readily can manipulate a flask weighing about 600 pounds. After the flask is rammed it is run off the ramming table on a pair of rollers on which it is rolled over on to the pattern drawing device. This machine may also be motor driven, although designed primarily for small jobbing shops where power may be unavailable. In addition to these mixers the reels are mounted on a horizontal instead of a vertical shaft. A flexible shaft grinder mounted on a hand truck and driven by a 1-horsepower motor was also displayed by the Adaptable Moulding Machine Co., which had one of the most comprehensive exhibits at the show.

A Pneumatic-Electric Machine

Combination pneumatic and electric jolt-ramming and pattern-drawing machines were displayed by the Pneulec Machine Co., Ltd., Smethwick, England. In these machines which have been previously described in THE FOUNDRY, a small electric motor is directly connected through a crank to a piston working in the lower end of the jolt-ramming cylinder, under the table plunger. The table is lifted by the compression of the air between the molds per day with these machines. The machines consume power only when they are being operated. The 3-horsepower machine will handle flasks weighing up to 600 pounds, and the 5-horsepower machine up to 1400 pounds. The Pneulec Machine Co., also showed a nickel-plated working model of its gas-fired core ovens which are fitted with indicating thermometers. A hand-operated tamper molding machine working on somewhat the same principle as a squeezer machine also was displayed; the squeezing or tamping head is mounted on a pivot at the back of the machine and counterballanced by means of a spring so that the operator may readily deliver a smart, packing blow to the sand, which is rammed in the flask with a minimum expenditure of energy and time, the

machine combining the effects of squeezing and hand ramming. This machine takes flasks up to 20 inches wide, 30 inches long and 6 inches deep. Cores made with the various types of core oils manufactured by the Pneulec company also were displayed.

American molding machines built under the Tabor patents were exhibited by MacNab & Southampton Row, London. This display included a 10-inch, shockless, jar-ramming, roll-over, pattern-drawing machine capable of handling flasks weighing up to 3800 pounds together with an improved Tabor 18 x 10-inch portable jar-ramming, roll-over and pattern-drawing machine with a 10-inch straight draw. It is said that the pattern is drawn vertically whether the machine is set on a level floor or not. Various other types of Tabor Machines were displayed by MacNab & Co., together with a 200-pound and a 400-pound nonferrous melting furnace which is said to melt 200 pounds of gunmetal with 25 pounds of coke in 19 minutes.

A pneumatic jar-ramming machine equipped with a pattern drawing feature by means of which the pattern may either be drawn away from the mold or vice-versa was exhibited by John Macdonald & Son, Ltd., Glasgow. In this machine the effect of the jar is absorbed on special striking columns. John Macdonald & Co. also showed a portable gasoline-driven air compressor which has a capacity of 74 cubic feet per minute and weighs only 880 pounds.

Hydraulic Jarring Machine

One of the principal features of the extensive display of Ph. Bonvillain & E. Ronceray, Paris, France, was a new plain jolt-ramming machine operated entirely by hydraulic power using water at high pressure according to the general principles developed by Bonvillain & Roncray. The ramming table of this machine is carried on a plunger which is enlarged in the middle so that two annular chambers are formed respectively at the top and bottom of the hydraulic cylinder. The upper chamber is the smaller of the two and is always in communication with the accumulator. The water is admitted to and discharged from the lower chamber alternately by a simple valve mechanism operating from a shaft. When water is admitted to the lower chamber the table is raised on account of the greater area of plunger exposed in this chamber, but when the pressure is released the table is brought back to rest with the force of the pressure in the upper chamber, in addition to its own weight, the purpose of this arrangement being to insure a sharp jolt without rebound. The shaft operating the valve may be rotated either by an electric motor, a small water turbine, or a ratchet gear engaging the table.

A combined hydraulic squeezer and jar-ramming machine also was displayed. The squeezer mechanism is similar to that of previous machines and is designed to ram both the cope and the drag in one operation. A small single active hydraulic jar-ramming cylinder also is attached so that the effects of both jolt and squeeze ramming may be taken advantage of. Bonvillain & Ronceray also exhibited various other types of their standard machines in operation, and in addition displayed an exceedingly interesting core oil by means of which cores may be dried in the air without heat. This exhibit was put on under the auspices of the British company organized by Bonvillain & Ronceray, known as the Universal System of Machine Moulding and Machinery Co., Ltd., London.

Pneumatic jar ramming and squeezing machines together with other foundry equipment was displayed by the Britannia Foundry Co., Coventry. Samuelson & Co., Banbury, showed a plate-molding machine adapted to pattern-plate or die molding and by means of an adjustable carriage to the use of ordinary flasks. The General Foundry & Engineering Co., Ltd., Lutterworth, Leicester, showed a number of hand-ram pattern-drawing machines in which the pattern-plate is raised by vertical shafts operated by long connecting rods instead of short toggles.

Drawings and photographs of the complete line of molding machines, including large jar-ramming machines with electrically operated roll-over devices built in the United States by the Osborn Mfg. Co., Cleveland, were shown under the direction of M. W. Zeman, general European director.

David McLain, Milwaukee, personally exhibited a large number of sample castings made of semisteel. The feature of this exhibit was a display of annealed semisteel hatchets, claw hammers and automobile tools said to possess characteristics similar to malleable iron castings.

There were a number of important exhibits of melting devices of various kinds. One of the most comprehensive of these displays was that of the Constructional Engineering Co., Ltd., Birmingham, England. This exhibit included bottom sections of a standard cupola fitted with Wood's patent blast control arrangement. The bottom sections of a special cupola with a melting capacity of 16 tons per hour equipped with a blast preheating device also was displayed together with small portable cupolas mounted on trunnions. The preheating device consists of a wind belt sunk into the side of the cupola so that the lining in front of the belt is only 3 inches thick, this portion of the lining being of carborundum sand. The tuyeres which connect with the bottom of this wind belt are, therefore, only 3 inches long. A preheat of about 800 degrees Fahr. is expected. The small cupolas are built in three sizes with capacities of 1120, 1680 and 2800 pounds per hour respectively. A self-contained, hydraulically operated pig iron breaker also was exhibited. It consists of a suitable anvil and an hydraulic plunger which is operated by a small pump connected to the machine. The pump may be worked either by hand or electric power. A motor-driven sand riddling machine with a capacity of three tons per hour also was displayed along with various other kinds of foundry equipment, including ladles, sand mills, pressure and volume indicators, etc.

Exhibit Cupolas

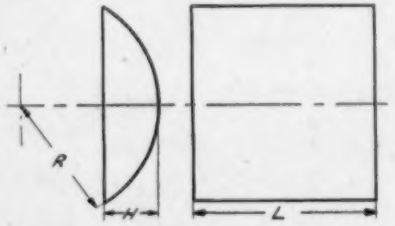
Cupolas also were exhibited by Thwaites Brothers, Ltd., Bradford. One of the cupolas in this exhibit, of four tons per hour capacity, was equipped with an electrically-operated skip-type charging device. The motor operates continuously in one direction and the skip is hoisted by means of an epicyclic gear arrangement similar to a Ford transmission. Thwaites Brothers also showed Blystont type sand mixers, positive pressure blowers equipped with roller bearings, and a turn-over plate molding machine.

Nonferrous melting devices were exhibited by the British Reverbatory Furnaces, Ltd., London, S. W. I., and the Morgan Crucible Co., Ltd., Battersea, London. The former showed a small open-hearth or reverbatory furnace designed to melt nonferrous metals with coal or coke fuel. It is said that the melting loss is only 3 to 4 per cent and that the loss by oxidation is minimized by the separation of the fuel from the metal. Pieces of scrap weighing up to 500 pounds can be melted. The Morgan company exhibited various examples of its standard crucible-type furnaces and crucibles, including a tilting furnace which may be either coke, oil or gas fired. Nonferrous melting furnaces also were shown by the Selas-Turner Co., Coventry and others.

A rather novel pig breaking device which is operated by means of a rifle

FORMULA FOR FINDING WEIGHT OF CAST STEEL SEGMENTAL BAR

By W. L. Tryon



To find the weight of a cast steel bar whose cross section is a segment of a circle, first divide the height by the radius, and in the table opposite this quotient find K. Then, the weight required is the product of K, the radius squared and the length.

$$W = KR^2L$$

If H is greater than R, find the weight of cylinder of Radius R and subtract weight of part cut away from cylinder.

H/R	K	H/R	K	H/R	K	H/R	K	H/R	K	H/R	K	H/R	K
0.030	0.0028	0.134	0.0257	0.190	0.0430	0.246	0.0628	0.302	0.0845	0.358	0.1081	0.414	0.1331
0.040	0.0043	0.136	0.0263	0.192	0.0436	0.248	0.0635	0.304	0.0854	0.360	0.1089	0.416	0.1341
0.050	0.0060	0.138	0.0268	0.194	0.0443	0.250	0.0642	0.306	0.0862	0.362	0.1098	0.418	0.1350
0.060	0.0078	0.140	0.0274	0.196	0.0449	0.252	0.0650	0.308	0.0870	0.364	0.1107	0.420	0.1359
0.070	0.0098	0.142	0.0280	0.198	0.0457	0.254	0.0657	0.310	0.0878	0.366	0.1116	0.422	0.1368
0.080	0.0120	0.144	0.0286	0.200	0.0463	0.256	0.0665	0.312	0.0886	0.368	0.1124	0.424	0.1377
0.090	0.0143	0.146	0.0292	0.202	0.0470	0.258	0.0672	0.314	0.0894	0.370	0.1133	0.426	0.1387
0.092	0.0148	0.148	0.0298	0.204	0.0477	0.260	0.0680	0.316	0.0903	0.372	0.1142	0.428	0.1396
0.094	0.0152	0.150	0.0304	0.206	0.0484	0.262	0.0688	0.318	0.0911	0.374	0.1151	0.430	0.1405
0.096	0.0157	0.152	0.0310	0.208	0.0491	0.264	0.0695	0.320	0.0919	0.376	0.1159	0.432	0.1415
0.098	0.0161	0.154	0.0316	0.210	0.0498	0.266	0.0703	0.322	0.0928	0.378	0.1168	0.434	0.1424
0.100	0.0166	0.156	0.0322	0.212	0.0505	0.268	0.0711	0.324	0.0936	0.380	0.1177	0.436	0.1433
0.102	0.0171	0.158	0.0328	0.214	0.0512	0.270	0.0719	0.326	0.0944	0.382	0.1186	0.438	0.1443
0.104	0.0176	0.160	0.0334	0.216	0.0519	0.272	0.0726	0.328	0.0953	0.384	0.1195	0.440	0.1452
0.106	0.0182	0.162	0.0340	0.218	0.0526	0.274	0.0734	0.330	0.0961	0.386	0.1204	0.442	0.1462
0.108	0.0187	0.164	0.0346	0.220	0.0533	0.276	0.0742	0.332	0.0969	0.388	0.1213	0.444	0.1471
0.110	0.0192	0.166	0.0353	0.222	0.0540	0.278	0.0750	0.334	0.0978	0.390	0.1222	0.446	0.1480
0.112	0.0197	0.168	0.0359	0.224	0.0547	0.280	0.0757	0.336	0.0987	0.392	0.1231	0.448	0.1489
0.114	0.0202	0.170	0.0365	0.226	0.0554	0.282	0.0765	0.338	0.0995	0.394	0.1240	0.450	0.1499
0.116	0.0208	0.172	0.0371	0.228	0.0562	0.284	0.0773	0.340	0.1003	0.396	0.1249	0.452	0.1509
0.118	0.0213	0.174	0.0378	0.230	0.0569	0.286	0.0781	0.342	0.1012	0.398	0.1258	0.454	0.1518
0.120	0.0218	0.176	0.0384	0.232	0.0576	0.288	0.0789	0.344	0.1020	0.400	0.1267	0.456	0.1528
0.122	0.0224	0.178	0.0391	0.234	0.0583	0.290	0.0797	0.346	0.1029	0.402	0.1276	0.458	0.1537
0.124	0.0229	0.180	0.0397	0.236	0.0591	0.292	0.0805	0.348	0.1038	0.404	0.1286	0.460	0.1547
0.126	0.0235	0.182	0.0404	0.238	0.0598	0.294	0.0813	0.350	0.1046	0.406	0.1295	0.462	0.1556
0.128	0.0240	0.184	0.0410	0.240	0.0605	0.296	0.0821	0.352	0.1055	0.408	0.1304	0.464	0.1566
0.130	0.0246	0.186	0.0417	0.242	0.0613	0.298	0.0829	0.354	0.1063	0.410	0.1313	0.466	0.1575
0.132	0.0251	0.188	0.0423	0.244	0.0620	0.300	0.0837	0.356	0.1072	0.412	0.1322	0.468	0.1585

(*Concluded on Data Sheet No.* 438)

Note—This sheet may be cut into two sections 5 x 7 inches and may be readily bound in note book form.

FORMULA FOR FINDING WEIGHT OF CAST STEEL SEGMENTAL BAR

By W. L. Tryon

(*Concluded from Data Sheet No.* 437)

H/R	K	H/R	K	H/R	K	H/R	K	H/R	K	H/R	K	H/R	K
0.470	0.1595	0.546	0.1970	0.622	0.2362	0.698	0.2766	0.774	0.3181	0.850	0.3604	0.926	0.4032
0.472	0.1604	0.548	0.1980	0.624	0.2372	0.700	0.2777	0.776	0.3192	0.852	0.3615	0.928	0.4043
0.474	0.1614	0.550	0.1990	0.626	0.2382	0.702	0.2787	0.778	0.3203	0.854	0.3626	0.930	0.4054
0.476	0.1623	0.552	0.2000	0.628	0.2393	0.704	0.2798	0.780	0.3214	0.856	0.3638	0.932	0.4066
0.478	0.1633	0.554	0.2010	0.630	0.2403	0.706	0.2809	0.782	0.3225	0.858	0.3649	0.934	0.4077
0.480	0.1643	0.556	0.2020	0.632	0.2414	0.708	0.2820	0.784	0.3236	0.860	0.3660	0.936	0.4088
0.482	0.1652	0.558	0.2031	0.634	0.2424	0.710	0.2831	0.786	0.3247	0.862	0.3671	0.938	0.4099
0.484	0.1662	0.560	0.2041	0.636	0.2435	0.712	0.2842	0.788	0.3258	0.864	0.3682	0.940	0.4111
0.486	0.1672	0.562	0.2051	0.638	0.2445	0.714	0.2852	0.790	0.3269	0.866	0.3694	0.942	0.4122
0.488	0.1682	0.564	0.2061	0.640	0.2456	0.716	0.2863	0.792	0.3280	0.868	0.3705	0.944	0.4133
0.490	0.1691	0.566	0.2072	0.642	0.2467	0.718	0.2874	0.794	0.3291	0.870	0.3716	0.946	0.4145
0.492	0.1701	0.568	0.2082	0.644	0.2477	0.720	0.2885	0.796	0.3303	0.872	0.3727	0.948	0.4156
0.494	0.1711	0.570	0.2092	0.646	0.2488	0.722	0.2896	0.798	0.3314	0.874	0.3739	0.950	0.4167
0.496	0.1721	0.572	0.2102	0.648	0.2498	0.724	0.2907	0.800	0.3325	0.876	0.3750	0.952	0.4179
0.498	0.1730	0.574	0.2112	0.650	0.2509	0.726	0.2918	0.802	0.3336	0.878	0.3761	0.954	0.4190
0.500	0.1740	0.576	0.2123	0.652	0.2520	0.728	0.2928	0.804	0.3347	0.880	0.3772	0.956	0.4201
0.502	0.1750	0.578	0.2133	0.654	0.2530	0.730	0.2939	0.806	0.3358	0.882	0.3784	0.958	0.4212
0.504	0.1760	0.580	0.2143	0.656	0.2541	0.732	0.2950	0.808	0.3369	0.884	0.3795	0.960	0.4224
0.506	0.1770	0.582	0.2154	0.658	0.2551	0.734	0.2961	0.810	0.3380	0.886	0.3806	0.962	0.4235
0.508	0.1780	0.584	0.2164	0.660	0.2562	0.736	0.2972	0.812	0.3392	0.888	0.3817	0.964	0.4246
0.510	0.1789	0.586	0.2174	0.662	0.2573	0.738	0.2983	0.814	0.3403	0.890	0.3829	0.966	0.4258
0.512	0.1799	0.588	0.2185	0.664	0.2583	0.740	0.2994	0.816	0.3414	0.892	0.3840	0.968	0.4269
0.514	0.1809	0.590	0.2195	0.666	0.2594	0.742	0.3005	0.818	0.3425	0.894	0.3851	0.970	0.4280
0.516	0.1819	0.592	0.2205	0.668	0.2605	0.744	0.3016	0.820	0.3436	0.896	0.3862	0.972	0.4292
0.518	0.1829	0.594	0.2216	0.670	0.2615	0.746	0.3027	0.822	0.3447	0.898	0.3874	0.974	0.4303
0.520	0.1839	0.596	0.2226	0.672	0.2626	0.748	0.3038	0.824	0.3459	0.900	0.3885	0.976	0.4314
0.522	0.1849	0.598	0.2236	0.674	0.2636	0.750	0.3049	0.826	0.3470	0.902	0.3896	0.978	0.4326
0.524	0.1859	0.600	0.2247	0.676	0.2647	0.752	0.3060	0.828	0.3481	0.904	0.3907	0.980	0.4337
0.526	0.1869	0.602	0.2257	0.678	0.2658	0.754	0.3071	0.830	0.3492	0.906	0.3919	0.982	0.4348
0.528	0.1879	0.604	0.2268	0.680	0.2669	0.756	0.3082	0.832	0.3503	0.908	0.3930	0.984	0.4359
0.530	0.1889	0.606	0.2278	0.682	0.2680	0.758	0.3093	0.834	0.3514	0.910	0.3940	0.986	0.4371
0.532	0.1899	0.608	0.2288	0.684	0.2690	0.760	0.3104	0.836	0.3526	0.912	0.3953	0.988	0.4382
0.534	0.1909	0.610	0.2299	0.686	0.2701	0.762	0.3115	0.838	0.3537	0.914	0.3964	0.990	0.4393
0.536	0.1919	0.612	0.2309	0.688	0.2712	0.764	0.3126	0.840	0.3548	0.916	0.3975	0.992	0.4405
0.538	0.1929	0.614	0.2319	0.690	0.2723	0.766	0.3137	0.842	0.3559	0.918	0.3986	0.994	0.4419
0.540	0.1939	0.616	0.2330	0.692	0.2734	0.768	0.3148	0.844	0.3570	0.920	0.3998	0.996	0.4427
0.542	0.1950	0.618	0.2340	0.694	0.2744	0.770	0.3159	0.846	0.3581	0.922	0.4009	0.998	0.4439
0.544	0.1960	0.620	0.2351	0.696	0.2755	0.772	0.3170	0.848	0.3593	0.924	0.4020	1.000	0.4450

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Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

cartridge, was displayed by the Temple Cox Research Co., Ltd., Bromley, Kent, England, in connection with the United Brassfounders & Engineers, Ltd., Cornbrook, Manchester. The device consists of a plunger weighing five pounds fitted into a vertical cylinder so arranged as to straddle the pig to be broken. A breech mechanism also is provided in which a cartridge containing high pressure powder, but of course, no bullet, is inserted. The expansion of the gas generated by the explosion causes the plunger, which moves about five inches, to strike the pig a heavy blow breaking it instantly. It is said that one man can break pig iron with this machine, which weighs 250 pounds, at a cost of 20 cents a ton.

Instruments for use in connection with foundry melting furnaces and for other purposes in foundries were displayed by the Cambridge & Paul Instrument Co., Ltd., Cambridge, England. This exhibit included an electrical carbon-dioxide recording instrument which does away with chemicals in making CO_2 determinations. Heat recording instruments also were exhibited by the Foster Instrument Co., Letchworth.

Among the exhibitors of sand preparing machines was an interesting crane-type heap sand mixer built by Ritchie, Hart & Co., Ltd., Belfast, Ireland. This machine consists of a 3-foot wheel on the rim of which several toothed sand-dressing buckets are mounted. The wheel is suspended in a frame to which an electric motor is attached, the motor being connected to the wheel through worm and chain gearing.

Alfred Herbert, Ltd., Coventry, showed a two reel type of sand mixing machine with a capacity of 400 pounds per minute. The reels are mounted on a vertical shaft. Various types of Norton grinders also were shown by Alfred Herbert, Ltd. The Ateliers Ivan Lamoreux S. A., Liebe, Belgium, exhibited a green sand and a dry sand grinding machine, and the Silica de Peissand, Brussells, showed various types of high grade Belgian molding sands some of which are exported to the United State for stove molding.

Motor operated swing grinding machines fitted with roller bearings were shown by A. W. Sainsbury, Ltd., Sheffield. An unusually complete display of grinding wheels of various types and also of carborundum sand for lining furnace, ladles, etc. was exhibited by the Carborundum Co., Ltd., Manchester, which is affiliated with the Carborundum Co., Niagara Falls, New York. Another comprehensive display of grinding wheels was shown by B. R. Rowland, Reddish, near Stockport, England, together with two double-headed floor grinding machines specially designed for foundry service. Grinding wheel exhibits also were shown by the Universal Grinding Wheel Co., Stafford, and others. Wadkin & Co., North Evington, showed various types of woodworking machinery suitable for installation in pattern shops.

Thee sand-blast industry was represented by the Tilghman's Patent Sand Blast Co., Broadheath, near Manchester. This company was organized by Mr. Tilghman, one of the inventors of the sand blast. Cabinet and tumbling barrel machines of various types were displayed together with air compressors and accessory apparatus.

Demonstrations of oxyacetylene welding were given by Cabric Ltd., London, E. C. I. This company also exhibited its portable welding and cutting tools, flare lights, hand lamps, etc. A complete exhibit of foundry scales and weighing machines was made by W. & T. Avery Ltd., Soho Foundry, Birmingham.

Pig iron, castings, foundry supplies, etc., were shown by William Cumming & Co., Ltd., Glasgow; Birtley Iron Co., Durham; Shotts Iron Co., Ltd., Edinburgh; William Beardmore & Co., Ltd., Glasgow; Consett Iron Co., Durham; Andrew Handyside & Co., Denby; Rudge-Littley Ltd., West Bromwich, and others.

An unusual feature of this exhibition was what was termed "the modern foundry." It occupied one entire bay in the exhibition hall and consisted of working examples of all types of foundry equipment, the idea being to show the equipment of a small, up-to-date gray iron foundry as it would actually be assembled completely in a practical plant. Various exhibitors furnished apparatus, the choice being made by ballot. Among the principal contributors were The Adaptable Moulding Machine Co., Birmingham, which furnished molding machines; and The Constructional Engineering Co., Ltd., Birmingham, which furnished cupolas, etc.

THE FOUNDRY PRESENTED TYPICAL AMERICAN PRACTICE THROUGH A COMPLETE DISPLAY OF PHOTOGRAPHS

Every afternoon during the exhibition, moving pictures were shown illustrating modern production methods in British engineering works. The famous film of Rogers & Co., Chicago, entitled "From Mine to Molder," illustrating completely the manufacture of iron and steel in the United States, was the feature of this department of the exhibition. This was the first time this film has been shown abroad.

A special series of lectures also was arranged in connection with the exhibition. These lectures were given at 7:30 p. m. each evening from June 19 to 23 respectively. Two lectures on semisteel which were delivered by David McLain, Milwaukee, were largely attended, as were lectures by A. J. G. Smout on "The Fundamental Principles of Foundry Practice," and Dr. L. Aitchison on "The Properties of Cast Iron at High Temperatures."

Contrast Irons of Two Nations

Discussion at Birmingham Conference of Institution of British Foundrymen Develops Comparison of Gray Iron and Malleable Casting Practice of Great Britain and America

AT THE nineteenth annual meeting of the Institution of British Foundrymen which was held in Birmingham, England, June 21-23, in conjunction with the first British exhibition of foundry equipment and supplies, further impetus was given to the project of a big international foundrymen's congress and exhibition, to take place a year or so hence. Public reference to the plans now being formulated

OLIVER STUBBS MEDAL PRESENTED TO F. J. COOK

was made at the opening meeting in the Chamber of Commerce hall on Wednesday, June 21, again at the annual dinner Wednesday evening, and on other occasions throughout the week.

The President's Luncheon

Oliver Stubbs, managing director of Joseph Stubbs, Ltd., Manchester, the retiring president, gave a luncheon to the leading representatives of the French, Belgian and American foundrymen's associations at which F. J. Cook and T. H. Firth who recently returned from America also were present. At this gathering, which was purely informal, details were discussed and a suggestion developed to hold an international congress in Paris in 1923, under the auspices of the several European organizations representing the castings industry, with the Association Technique de Fonderie de France as official host. Whether or not this project, which was endorsed by Emile Ramas, president of the French association and E. V. Ronceray, one of its most prominent directors, will materialize within the time now hoped for, there is no doubt that the plan in general is gathering momentum as a result of the support it received first at the American convention at Rochester and more recently at the British international convention in Birmingham.

International co-operation among foundrymen was the keynote of the Birmingham conference, emphasized by the international character of the exhibition held co-incidently in Bingley hall. The fact that peace, good will and understanding among nations is fostered more by the individual contacts established at conventions of technical and business associations than through political machinery was stressed by several speakers at the annual dinner at Birmingham, including Stanley G. Flagg, Jr., Philadelphia; Oliver Stubbs, the retiring president; Sir Herbert Austin and others. Mr. Flagg spoke at the dinner in response to the toast to the guests,

REVERSE OF MEDAL OFFERED BY EMPLOYERS FEDERATION

as the joint representative of the American, French and Belgian foundrymen's associations.

Papers From World Centers

The international character of the Birmingham convention was further developed at the technical sessions where papers were read by American, French and Belgian foundrymen. Enrique Touceda, Albany, New York, received an ovation on presenting the exchange paper on behalf of the American Foundrymen's association. Prof. Touceda's paper, the first portion of which is presented on another page of this issue, was entitled, "American Methods of Manufacture of Malleable Iron Castings and Some Data in Connection With the Finished Product." E. V. Ronceray, of Ph. Bonvillian and E. Ronceray, Paris, presented a paper on behalf of the Association Technique de Fonderie de France, and also as a member of the Institution of British Foundrymen, entitled, "On New Methods of Testing

Honor Visitors

AS A tribute to its foreign visitors and in recognition of their distinguished services to the foundry industry not only of their own countries but of the world, the principal foreign visitors to the Birmingham convention and exhibition were made honorary members of the Institution of British Foundrymen. These new honorary members are as follows:

Stanley G. Flagg Jr.
Past President, American Foundrymen's Association
Stanley G. Flagg & Co., Philadelphia

Enrique Touceda
American Malleable Castings association,
Albany, New York

David McLain
McLain's System, Milwaukee

Emile Ramas
President, Association Technique de Fonderie de France
Societe Francaise Metallurgique Procedes Griffin, Paris

E. V. Ronceray
Ph. Bonvillain & E. Ronceray, Paris

Joseph Leonard
President, Association Technique de Fonderie de Liege,
Herstal, Belgium

Jacques Varlet
Societe d'Esperance Longdoz
Seraing, Belgium

Cast Iron." The Association Technique de Founderie de Liege, Belgium, was represented by Jacques Varlet, foundry manager of the Societie Anon d'Esperance-Longdoz Seraing, who read a paper on, "Loam Molding in the Liege District." These speakers were also enthusiastically received. Their papers will be published subsequently in THE FOUNDRY.

In addition the British contributions to the technical program were noteworthy, including papers on "Semisteel" by J. Cameron, of Cameron & Robertson, Kirkintilloch, Scotland; "Safety in Foundry Operations", by R. W. Patmore, Industrial Welfare Society, London; "Some Influences of Low Temperature on the Strength and Properties of Cast Iron", by Prof. A. Campion, metallurgist, Falkirk, Scotland; "The Casting of Brass and Bronze", by O. Smalley, Newcastle-on-Tyne; and "Manufacture of Light Steel Castings" by H. Bradley, Sheffield.

Cook Awarded Medal

After the address of welcome, the feature of the business session, which preceding the reading of papers at the opening session June 21, was the first award of the Oliver Stubbs medal to F. C. Cook, Rudge-Littley Ltd., West Bromwich, England. This medal is to be given annually on behalf of the National Ironfounders Employers' Federation of Great Britain, by a vote of the council of the I. B. F. in recognition of distinguished services to the British foundry industry. Mr. Cook was the author of the exchange paper from the British institution read at the Rochester convention of the A. F. A. on June 6.

Officers for the ensuing year also were elected unanimously at the business session as reported by cable in the July 1 issue of THE FOUNDRY. Another international touch was given the convention through the election of seven of the most prominent foreign visitors honorary members of the Institution of British Foundrymen. This action was taken unanimously at the final session June 22. The names of the new honorary members are given in a box on page 584. Emile Ramas, president of the Association Technique de Fonderie de France, and Enrique Touceda of the American Foundrymen's association acknowledged the courtesy implied by the bestowal of these honorary memberships and expressed the spirit of solidarity which now prevails among foundrymen everywhere throughout the western world.

At the opening session on Wednesday, just prior to the address of H. L. Reason, the new president, a letter was read from C. R. Messinger, president of the American Foundrymen's association. This communication was brought to Birmingham personally by F. J. Cook. A cablegram from the Rochester convention of the American Foundrymen's association also was read.

In his presidential address, Mr. Reason dealt chiefly with the affairs of the I. B. F. including in his remarks a tribute to past president Thomas H. Firth for his efforts in connection with the royal charter which has been granted to the institution. Mr. Reason also suggested that each new member of the institution be given a handbook of foundry data. He recommended that the I. B. F. publish its proceedings semi-annually with monthly bulletins in the intervening periods. In the technical portion of his remarks he referred to the necessity for further research work on cast iron particularly in the field of corrosion in connection with which he mentioned the data on corrosion losses compiled by Sir Robert Hadfield.

Exhibition Circuit

AS PREVIOUSLY announced in a special cablegram to THE FOUNDRY, *a suggestion was made at the Birmingham show to inaugurate a European foundry exhibition circuit. This idea which contemplates holding an exhibition of foundry supplies and equipment in Great Britain, France and Belgium in consecutive years is now being worked out, and it is now believed that the exhibition may be held in Paris next summer under the auspices of of the Association Tecnique de Fonderie de France. Possibly, however the Birmingham exhibition may be made an annual affair, although suggestions also have been offered to amalgamate it with the British Industries Fair which is held in Birmingham every spring. The plan to have successive annual exhibitions in the three principal allied countries was favorably received and it is believed that this idea offers a practical solution of the European foundry exhibition problem.*

Semisteel Recognized

J. Cameron, of Cameron & Roberton, Kirkintilloch, Scotland, presented the first paper on the program, entitled "Semisteel."

Mr. Cameron said that hematite pig irons give good results when used with steel scrap, but that while the castings made with mixtures of cold blast irons and scrap are satisfactory, the results are disappointing from the standpoint of strength.

The discussion constituted a recognition of the usefulness of semisteel for engineering purposes, nearly every speaker testifying to the merits of this metal. Many of them paid tributes to the exhaustive research work on semisteel which has been done in America. Prof. Thomas Turner of Birmingham university, after paying a tribute to the work of the late W. J. Keep intimated that in his opinion semisteel was invented 18 years ago by Stirling who mixed wrought iron scrap with cast iron. He called his product *toughened cast iron* which Professor Turner said he believes is a more satisfactory term than semisteel. The good qualities of semisteel, continued Professor Turner, are not necessarily retained by repeated remelting, the aim in making semisteel being to obtain the maximum combined carbon without any free cementite and with finely divided graphitic carbon.

Criticizes Tests

E. V. Ronceray, who also paid a tribute to W. J. Keep's work, said that in his judgment separate test bars are unsatisfactory and indicated that he prefers a ball test for cast iron. During the war, he said, government tests and specifications actually prevented improvements in the manufacture of semisteel shells.

J. Shaw, Brightside Foundry & Enginering Co., Sheffield, after calling attention to the remarkably low sulphur, 0.038 per cent, in Mr. Cameron's semisteel, said that Mr. Cameron's experiments tend to show how little carbon is absorbed during the melting stage. In a large cupola run all day, he said, there would be little contact between the molten metal and the bed. Under these conditions, according to the speaker's observations, the recorded absorption of carbon was 2.81 per cent.

H. Field, John Harper & Co., Willenhall, pointed out that good results may be obtained with high phosphorus, and that it is not difficult to make semisteel with a tensile strength of 38,000 pounds per square inch with phosphorus 1.50 per cent, and with as close a grain as with low phosphorus.

J. E. Fletcher, director of research of the British Cast Iron Research association, F. J. Cook, Rudge-Littley, Ltd., West Bromwich, and A. Campion also discussed the paper. Mr. Fletcher pointed out that inasmuch as the use of high grade Scotch irons does not improve the strength, this

points to the fact that the semisteel mixture is carburized more satisfactorily when starting with a comparatively high carbon hematite pig iron. Mr. Cook confirmed this view but advocated 15 per cent steel with cold-blast iron for diesel-engine and other castings of similar nature on account of advantages such as closeness of grain which compensate for any loss in tensile strength.

Professor Campion said that only 0.5 to 0.6 per cent carbon is absorbed from the coke when the steel melts in the cupola, and that the main absorption comes from the passage of the metal through the bed charge. In a cupola in which the height of the bed charge was 12 per cent of the diameter he said the carbon absorption was 1.90 to 2.00 per cent; whereas in a cupola with a bed charge 36 per cent of the diameter the absorption was 2.60 per cent; and with a bed 72 per cent of the diameter, the absorption was 2.75 per cent. Professor Campion said he had melted 100 per cent steel scrap and tapped it out of the cupola.

American Malleable Discussed

The paper on "American Methods of Manufacturing Malleable Iron Castings," by Enrique Touceda was enthusiastically received. In the discussion, in which F. J. Cook, Oliver Stubbs, Prof. Thomas Turner, J. E. Fletcher and Stanley G. Flagg, Jr., participated, all of the speakers complimented the author on the unusually comprehensive paper he had presented and the British speakers all expressed their appreciation of his courtesy in coming to Great Britain to read his paper in person.

Professor Touceda's paper was presented as the official exchange paper from the American Foundrymen's association, and in connection with it the council of the I. B. F. says in its annual report that "we attach very much importance to the interchange of papers and hope in the future much more progress will be made in this direction."

L. Piedboeuf, Fonderies et Ateliers Simonon, Herstal, Belgium, discussed the paper on behalf of the Belgian foundrymen. Mr. Flagg pointed out how from the American point of view 17 per cent elongation is now considered too low, the average at present in the United States being 25 to 30 per cent. Professor Turner said that British malleable foundrymen should pay attention not only to the metallurgical details, but to the heating, lighting and general arrangement of their shops along lines followed in the United States, and he also said that in view of Professor Touceda's remarks regarding chromium it may eventually be necessary to analyze pig iron for chromium and other rare elements. Mr. Fletcher defended British malleable iron by pointing out that the big market in America makes it possible to use methods which are impracticable in Great Britain, where, for instance, it is necessary to use shorter and consequently less efficient air furnaces.

Testing Cast Iron

In an important paper entitled, "New Methods of Testing Cast Iron," by E. V. Ronceray of Ph. Bonvillain and E. Ronceray, Paris, the work of M. Fremont and M. A. Portevin is outlined. Mr. Ronceray said that a great deal of advancement could be realized in foundry practice by the systematic use of test methods such as those developed by these eminent Frenchmen. Mr. Ronceray's paper describes Fremont's and Portevin's methods in detail. It is said that Fremont advocated the transverse test only for the study of the metal and conditions of specifications, preferring the shearing test for the inspection of castings. Mr. Ronceray also fully described Mr. Portevin's ball test which is based on the Brinell test, the strength of the metal and its elasticity being determined from the diameter of a ball impression and the force required to make it. Mr. Ronceray concluded his paper with a strong plea for the perfection of internationally acceptable testing methods.

Origin of the I. B. F.

THE 1922 convention called attention to the fact that the Institution of British Foundrymen originated in Birmingham. This original conference, according to present records, was held on April 9, 1904 at the Cobden hotel, and at this meeting only six were present, including F. J. Cook, Robert Buchanan, F. Finch, J. Ellis, Thomas Vickers, and W. Macfarlane.

In a written discussion, J. Shaw, Brightside Foundry & Engineering Co., Ltd., Sheffield, said in part:

"I agree with Mr. Fremont that the transverse test is reliable for gray iron. With regard to the impact test, I hold the contrary view, having found it most reliable after two years daily use. There is no doubt M. Fremont's idea is the right one, that no test is equal to one made from the actual casting. Whether the small test pieces he uses, roughly 5/16 x 3/8 x 1 3/8 inches, are large enough to give true indications of the transverse strength, and more particularly the deflection is open to doubt. The shearing test is also open to doubt, but I think that the machinability of a casting would bear some relation to the shearing test."

In discussing this paper, several speakers agreed with the author and sentiments were expressed which it is hoped will lead to real results in the direction of the standardization of cast-iron test methods. In this direction the work of the British convention again dovetails with that of the American Foundrymen's association at its recent meeting in Rochester.

An exceedingly interesting paper on loam molding was read by Jacques Varlet, foundry superintendent of the Societe d'Esperance Longdoz, Seraing, Belgium. The discussion hinged around methods of training apprentices, several speakers pointing out the difficulties under modern conditions of suitable training in such highly skilled work as loam molding. A. H. Young, North Eastern Marine Engineering Co., Wallsend-on-Tyne, complimented the work of the Birmingham technical school in this direction.

In the discussion of a paper on "The Influence of Low Temperature on the Strength of Cast Iron," by A. Campion and J. W. Donaldson, Enrique Touceda described a series of tests recently made in America on specimens cast in the form of a letter *K* for the purpose of determining the amount of shrinkage due to low temperature. As a result, Professor Touceda advocated the melting of cast iron as hot as possible but pouring it as cold as possible taking into account the fact that metal poured too cold almost invariably contains a great number of blowholes.

Nonferrous Paper Read

The only paper on nonferrous foundry practice presented at the Birmingham meeting was that by O. Smalley, Newcastle-on-Tyne, entitled, "The Development and Manufacture of High Tenacity Brass and Bronze." In this paper the author speaks of the development of complex high strength brasses and advocates certain methods of manufacture. Dr. Percy Longmuir, Sheffield, opened the discussion by pointing out that many of the difficulties with high-strength bronzes result from zinc losses in melting. He advocates taking samples during melting as in open-hearth furnace practice, and if necessary making up the deficiency of zinc. He said that if the amount of zinc in the alloy is kept constant, the tensile strength will also

be kept constant provided, as the author said, that the casting temperature is watched. V. C. Faulkner, editor of the *Foundry Trade Journal*, London, pointed out the necessity for lead in these alloys in order to provide free cutting properties. H. L. Reason said it is impossible to make high tensile strength bronze by rule of thumb methods, but that, on the contrary, the constituents, melting losses and pouring temperature must each be under scientific control. An alloy which will not give 15 to 25 per cent elongation, he said, is too hard for commercial use for the reasons stated.

The discussion of the paper on "Light Steel Castings" by H. Bradley, Sheffield, centered around the question of green versus dry sand molds. D. Wilkinson, Austin Motor Co., Birmingham, while admitting the desirability of green sand for small steel castings, said he would not advocate it for castings weighing three or more tons, in these latter cases the dry sand mold being both safer and cheaper.

A splendid entertainment program was provided throughout the convention. In addition to the annual dinner, June 21, the Lord Mayor of Birmingham gave a garden party on June 22, and the local reception committee tendered a luncheon to the visiting members and guests on Friday, June 23, after which there were excursions to Stratford-on-Avon, Warwick, Kenilworth and Leamington. The arrangements for plant visitation were unusually complete and among the shops visited were those of W. & T. Avery, Ltd.; Bellis & Morcom; Allen Everitt & Sons, Ltd.; and the Dunlop Rubber Co.

Producing Manganese Bronze Alloys

BY ERNEST J. DAVIS

A NUMBER of elements enter into the composition of the widely used alloy, known as manganese bronze, copper, zinc, tin, iron, aluminum, manganese and sometimes nickel being used. The composition of manganese bronze varies over a wide range, and depends somewhat upon the physical properties required. The following composition is the one mostly adopted for general work:

	Per Cent
Copper	57.5
Zinc	40.0
Tin	1.00
Iron	1.00
Aluminum	0.20
Manganese	0.20

Tin, iron and manganese are added with the intention of giving strength to the alloy, and if added in excess, separate at the crystal boundaries as hard and brittle compounds which materially lower the mechanical properties of the alloy. These hard compounds are liable to segregation.

Manganese bronze may be manufactured from reclaimed scrap as satisfactorily as from virgin metal, provided the scrap is carefully sorted and cleaned before use. Aluminum is used for cleaning purposes and as a deoxidizer. Manganese is usually added as ferromanganese, and the balance of iron is added in the form of mild steel turnings. Cupro manganese may be used but is more expensive. In a virgin-metal charge the steel turnings and ferromanganese are added with the copper, and the whole is melted under charcoal. The tin and aluminum are then added, and lastly the zinc. As a guide to the correct zinc addition a piece for fracture test is cast in a small chill mold and carefully cooled under standard conditions, then fractured. By matching the fracture with a standard fracture the necessary zinc addition is determined. The metal is sweetened to a standard *sparkle* to give the required tests. Virgin-metal charges are usually pot charges, and the metal is ingoted. For large castings, the ingoted metal is remelted in a reverberatory furnace.

Lead is generally present in this alloy; not intentionally added, but entering as an impurity of the spelter. Up to 0.50 per cent it has little effect on the properties of the alloy.

The casting temperature is an important factor in obtaining the best results with manganese bronze. This temperature varies somewhat according to the composition, but usually runs between 900 and 950 degrees Cent. The casting temperature also varies with the size of casting.

The strength of manganese bronze varies over a wide range. It may have as low as 67,000 pounds per square inch tensile strength, or as high as 100,000 pounds per square inch, according to its composition. To be in a position to control the strength of manganese bronze, it is necessary to give some consideration to the constitution of the alloy. For this purpose manganese bronze may be considered as a high brass. The constitution of the brasses, or alloys of copper and zinc, consists of a series of solid solutions. The ones we are interested in are the alpha and the beta solid solutions. Manganese bronze for general purposes consists of a mixture of alpha and beta solid solution. The range of strength obtainable with this alloy is controlled by the proportion of these two solid solutions, the alpha being of low tensile strength and the beta giving high strength.

To obtain 67,000 pounds per square inch tensile and 25 per cent elongation 20 to 25 per cent alpha is worked to. To obtain a tensile strength of 90,000 pounds per square inch or over, an all-beta structure is worked to. In the beta manganese bronze, tin should be absent, and care should be taken to work toward the alpha-beta end of the range, otherwise another constituent which is extremely brittle is liable to be present.

The elements aluminum, manganese iron, tin and lead replace zinc in the alloy, and advantage is taken of this in compounding the alloy to work with a zinc equivalent. The elements enumerated replace zinc in the following proportions:

Aluminum	6
Tin	2
Lead	1
Iron	0.9
Manganese	0.5

The zinc equivalent is obtained by multiplying the percentage of each of the above elements in the alloy by the respective numbers, and adding the sum of the results to the percentage of zinc present in the alloy. The copper figure is then added, and the result, divided into the above apparent zinc figure, gives the zinc equivalent.

To find the amount of alpha equivalent to a certain zinc equivalent the following formula is used.

Let Z = Zinc equivalent
A = Alpha present
Then A = 465 — 10 Z.

The transverse strength of fire clay under severe conditions of temperature and load has been thoroughly investigated by the bureau of standards and it has been shown that above 1300 degrees Cent. the transverse strength is a negligible quantity from the standpoint of design.

Making Malleable Castings--I

Suggestions Are Offered Covering the Principles Governing the Layout of an American Malleable Foundry—How Air Furnaces Are Designed—Suggestions for Bungs and Grates

BY ENRIQUE TOUCEDA

DURING the past year inquiries pertaining to the practical details of malleable castings manufacture have been received from France, Belgium, Italy, Australia, and Japan. The author has received visits from engineers from abroad who have seemed greatly interested in the practical rather than the metallurgical details of this industry. It is the author's thought that if he took as a guide the character of these inquiries and the various questions that have been asked him by these visitors, he would not miss the ground that members would prefer to see covered, rather than attempt to enter into an academic discussion in regard to the mechanism of graphitization and other controversial matter concerning which so much has been written of late, or in dwelling on other strictly metallurgical details that have been so ably covered by many others, and particularly by H. A. Schwartz, whose book, compiled from articles he has written for *The Iron Trade Review*, is about to be issued.

Starting with the lay-out of a malleable plant, the details of which should have serious consideration, it is obvious that its correct plan will be dependent upon the plant capacity specified, and the shape of the building site. In connection with the latter, high ground should be selected, if possible, while low ground that is naturally wet and cannot be successfully drained should be shunned as worthless, for if annealing ovens are erected in such a locality annealing difficulties will prove to be perpetual. Whether the plant is to consist of one or various working units, and even if the raw materials are to be handled by a crane, it is desirable that each kind be stored as near to the metallurgical apparatus in which it is to be used as is possible. It is advisable that the sidings where the raw materials are to be discharged, the tracks be elevated on trestles of a height and length that will admit of the rapid and cheap discharge of car contents. In storing the molding, face and core-sand, a saving will result if the roof of the buildings in which they are to be placed is flush with the tracks which may be elevated on the trestle, in order that the cars can be discharged directly through roof openings into the building or sheds.

Irrespective of the size of the plant, the various departments in each unit should bear such a relation to each other than the product from the start of operations and at each step in the process should be continuously approaching the shipping room in the most direct manner possible. Economy in construction will result if each separate department is dimensioned strictly on the basis of providing little room in excess of that which will occasion congestion when running at maximum capacity. Experience has convinced the author that, in rare instances only, are malleable-iron plants ever run at maximum capacity, for when business is booming labor is scarce and inefficient, and when labor is plenty and men are willing to do a fair day's work, there is a dearth of business. Therefore some crowding in the various departments can be tolerated at times that prove exceptional. The one-story, straigth line plant with capacity of 25 to 35 tons of castings per day with core room and shipping rooms at extreme ends, and foundry, hard-iron mills, trimming, grinding and sandblast room, annealing department, and soft mills in between and located in the order named, will be found convenient. This may be arranged to permit considerable economy in construction, while admitting expansion. The character of building unit, very popular at the present time in the United States, is the one-story steel skeleton type with curtain walls, brick pilasters, and concrete foundations. This has either a saw-tooth roof, or one of usual construction with sufficient pich, a monitor running the full length of the building with window sashes hinged at the top to swing inward, and sashes in the curtain wall pivoted at the center. The roof covering commonly is of slate, slag, fabricated cement-asbestos tile, or other fireproof material. The one-story building of this type with either style roof possesses many advantages, in that maximum lighting is assured, ventilation is facilitated, and fire risk minimized.

One of the most important items to be considered is that of efficient ventilation, particularly in the foundry building and core room. Without a constant supply of fresh air, energy of body and alertness of mind are gradually deadened as the day progresses. When activity and vigor are lowered the effect always is noticeable in increased foundry loss on late heats, while the hazard, due to accident, is augmented.

For effective ventilation dependence should not be placed wholly upon the monitor; but it should be supplemented by well-designed ventilators, positioned in such a manner that a steady discharge of air is assured.

Efficient and uniform heating of the foundry proper is a problem replete with difficulty, owing to the variable conditions that must be met. During the night the natural fall in temperature, coupled with the condition brought

WHEN the author of this paper was designated by the American Foundrymen's association to prepare and present the second exchange paper offered by that technical society to the Institution of British Foundrymen, an obligation was incurred. Malleable iron casting practice abroad differs widely from that which has been developed from the same beginnings in America. Mr. Touceda, with this fact in mind fulfilled the obligation and prepared a masterly discussion covering many intimate details which will be of interest to his associates on this side of the water, as well as to those foundrymen who serve the industry in other lands. The accompanying article presents only the first section of his paper. The remainder in which melting, metallurgical, heat treating and finishing practice and equipment are developed will be presented in two subsequent articles in THE FOUNDRY.

Abstracted from the exchange paper presented at the Birmingham conference of the Institution of British Foundrymen, June, 1922. The author, Enrique Touceda, Albany, N. Y., is consulting engineer for the American Malleable Castings association.

about by wetting and cutting the sand, produces a clammy dampness, hard to remove by the time the men report for work in the morning. In contrast to this condition, is the state of affairs that exist after a heat, when the air is filled with hot steam and a great amount of heat is radiating from the castings. Some foundries still use the salamander, which while cheap to install is expensive to run, takes up space of value, interferes somewhat with crane service, and occasions loss of time due to the men congregating around it if they feel slightly cold. One of the best and most approved systems is to force warm air into the building by a blower system through pipes properly spaced to yield uniform heating. Live and exhaust steam from the power house or from a separate steam source designed for heating only, or from such a plan supplemented by steam from waste-heat boilers, is used in some plants in radiators hung in such a manner as to be out of the way but as near as practical to leakages of cold air to heat this air as it filters into the building.

The author has seen many plants where a waste-heat boiler-installation has proved to be a mistake. A waste-heat boiler has not been designed to date in such a manner that after furnace operations have ceased it can be hand-fired economically. In running but one heat per day, any saving would be offset by the huge amount of coal required to make steam for the remainder of the time, when power or heat was required. If the boiler is allowed to cool and electric power and steam for heating derived from a small auxiliary heating plant substituted, the maintenance cost will prove disastrous. The scheme works out in other cases, especially where the cost of electric power or coal is high; where two heats per day are run from the same furnace; where one boiler is used in common with two furnaces, and particularly when a great amount of power is required for sand-blasting purposes. Preference should be given to that type of boiler least affected by quick changes in temperature.

Floor Is Dangerous

The foundry floor is deserving of thought. Some favor the concrete floor, but the writer believes that if a vote were taken of the molders the decision would be in favor of almost any other type. The concrete floor is unquestionably hard on the feet, and dangerous in some particulars. When spills occur an eye may be lost or serious burns sustained due to the instantaneous generation of steam from the moisture on the floor surface. Serious accidents have occurred in carrying iron through the molder slipping on the rounded particles of metal that have been occasioned by spills. Even when the floor has been properly laid, it can be ruined through carelessness in shaking out the castings too hot.

Vibration Harmful

However, the worst feature of the concrete floor is its great tendency to transmit vibration. When bumpers or vibrators are used, the probability of shaking down dirt from the cope or the cope itself is great. A floor of hard-wood blocks properly laid on a sand foundation yields better all round service, and is equally good for the gangways or, if protected with a little packing where the pots are dumped, for the annealing room. When used in the annealing room a strip paralleling the front of the oven and 6 feet wide should consist of square annealed iron plate about 18 x 18 inches with lugs on the under side, and set in concrete, or smooth granite block, set in concrete and well grouted. Molten iron has no other effect on wood block than to produce a surface char, which defects are shallow, and when present become filled and well protected by sand. The blocks should be laid in straight parallel course, with the grain of the wood vertical, care being taken to keep straight courses and close joints. All courses should break joints alternately by a lap of at least 2 inches, and should be filled with a hot, low-melting-point pitch of a consistency that will flow like water, to the end that all crevices will be completely filled. Against the sides of the building and around all foundations expansion joints should be made by placing a 1 x 4 inch tapered board on edge against the sides of the building and around foundations. The boards subsequently should be removed after the blocks are laid and rolled so that the void can be filled with hot asphalt to within ¼ inch of the wearing surface of the floor. The dirt, or clay, foundry floor is the safest, and the one that is most popular with the molder. It is comparatively inexpensive, and, if given proper attention, can be kept level and in excellent condition, while if a standard travelling sand cutter is used, there will be no danger of the floor being cut, provided precaution is taken to see that the tread of the wheels are made sufficiently wide to prevent their sinking into the ground.

The author believes that if the molder was asked what constitutes at the present time his hardest and most exacting task, if casting surface is a vital proposition, he would state, cutting sand. It is getting increasingly difficult to employ molders owing to the disagreeable nature of the work and the conditions under which the work is done, coupled with the fact that an equal wage can be earned in other occupations. After a lengthy shut-down those molders who have secured jobs in other lines generally refuse to return to the foundry on the resumption of operations. The fact is being recognized that something must be done to lighten his labor and make his living conditions within the plant square as far as possible, with what obtains in other industries. That the standard type of travelling sand cutter has not been more generally used is due to the fact that molding conditions in the malleable-iron foundry are different from those existing in foundries where other types of castings are made. In malleable-iron practice, molds usually are placed on the floor between heats, so it has been found impracticable in many instances to run the machine from pile to pile owing to the short time available and the confusion that would result if this was attempted. To overcome this difficulty, a cutting machine has been devised to operate as a unit with a monorail hoist, to which it is attached by two hoisting cables.

Handling Materials

The following hints may prove of value in the layout of a straight line foundry of medium capacity. A monorail crane so located that it passes from end to end of the foundry building and directly over two air furnaces symmetrically distanced as to molding space and set crosswise of the building, in combination with an electrically-driven 2 or 3-ton transfer bridge of 30 to 40-foot span that will admit of easy and rapid exit out of and entrance into the foundry, will pay for itself within a reasonable period. Through the latter arrangement the air-furnace charges can be placed on the floor space beneath the bridge at its entrance to the building, to be taken subsequently to the furnaces. Such a scheme yields fairly complete crane service to both yard and foundry, while for a slight additional expenditure the monorail can be extended to the other departments if, as should be the case, a uniform overhead clearance of at least 15 feet has been provided throughout the entire building unit.

In larger foundries it will be found that a more complete system of crane service is demanded by conditions. The travelling bridge crane service for the malleable-iron foundry differs in the majority of cases from what should

obtain in the case of the gray-iron foundry, for it is rarely used for drawing patterns or for handling finished molds. In some malleable-iron foundries, however, such as those making heavy railway work, while the requirements are quite similar, it is for a different reason. The large bottom pour ladle is now generally and successfully used for pouring molds for this class of work. The latter and former condition call for a travelling speed of from 1 to 5 feet per minute. Pouring metal through a nozzle from a large ladle suspended from a crane and passing from mold to mold necessitates careful control of the speeds. Consequently, the travelling and hoisting speed particularly should be adapted to the character of work. In the absence of a specific design of building, it is not possible to indicate the best arrangement of travelling crane and supplemental crane installation. Such details are familiar to the structural engineer, and are not as serious as those to which reference has been made, if to these be added the fact that any crane should have a positive system of mechanical brakes, have electrical equipment as simple as possible, and so constructed as to prevent the admission of dust or dirt.

The lifting magnet, used in connection with the crane, in the writer's opinion, is an indispensable accessory when the present labor situation is considered. Those who have seen men shaking out hot castings from steaming sand, need not be told that this constitutes a disagreeable task. Aside from this, when the castings are shaken out and piled, much burnt sand is left in a heap on each floor that subsequently must be collected from all the floors in use. Castings can be quickly removed by the magnet and the core wires, the cores themselves for the most part, and the chills are removed at the same time, and deposited at convenient places, from which the burnt sand can be easily and quickly taken to the dump, and the wire and chills recovered.

If the plot of ground is rectangular, a convenient layout of building is in the shape of a deep channel, one leg consisting of the foundry building, mainly, say 136 x 300 feet, 1300 to 1500 square feet of molding space per ton of castings, the square feet depending upon whether the work is heavy or light, the other leg containing, for the most part, the annealing room, say, 95 x 300 feet, while the web, a building 50 x 300 feet, connecting and opening into the two buildings that form the legs of the channel. The situation can be understood easily by reference to the arrangement of the departments as given for the straight line plant by simply considering that the straight line is bent in the form of a channel, the various departments following in the same order as in that construction. Through this design there would be a court about 70 feet wide to provide light and ventilation, and in which a wash room can be built, easy of entrance from any of the main buildings.

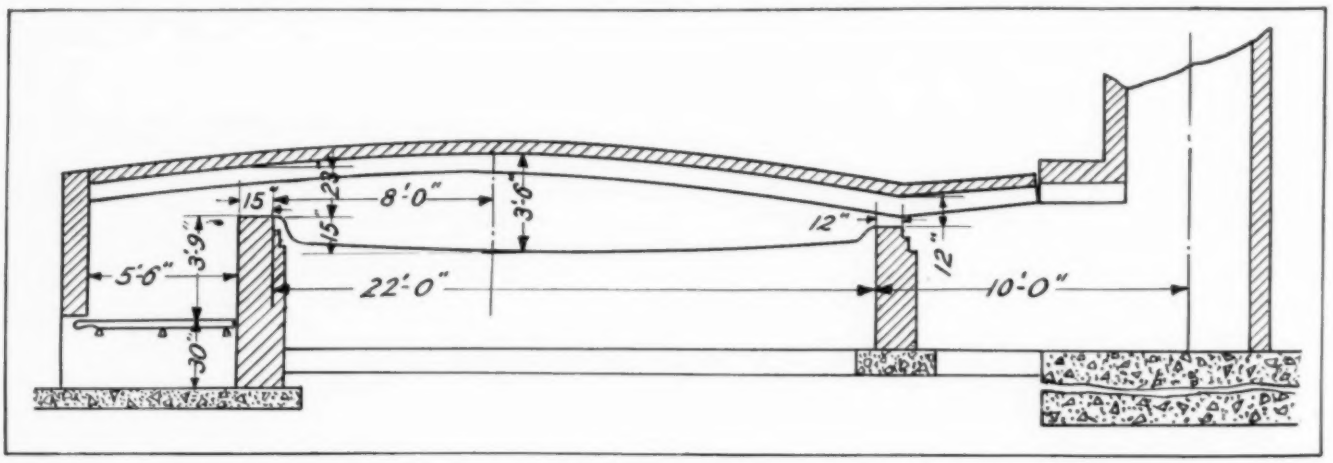


FIG. 1—RECOMMENDED DESIGN FOR A MALLEABLE IRON AIR FURNACE OF 15 TONS CAPACITY

Composition Recommended

A description of the black-heart malleable-iron process has appeared in so many papers that have been written within the past few years that the author feels certain members must all be very familiar with it. On this account a very brief explanation only will be given. The castings, as cast, whether made in the cupola, air-furnace, open-hearth or electric-furnace, must not only consist of white iron in which no trace of primary graphite exists, but in order that the finished product, after heat-treatment, be of normal fracture and superior in mechanical properties its composition must lie between certain definite limits. The white-iron composition that the author would recommend for best all round conditions, embodying facility of conversion, fluidity, shrink, static and dynamic strength, and ductility in final product, is of necessity and for obvious reasons a compromise. Such a composition is: Silicon, 0.90; phosphorus, 0.20; sulphur, 0.060; manganese, 0.25; and combined carbon, 2.35 per cent.

Later, some remarks will be made concerning permissible limits, but while at this point, the author desires to explain that the recommendations he will give in regard to both melting and conversion, are based upon works conditions and not upon what can be accomplished by a scientist in a laboratory apparatus of easy and positive control. In the United States the cupola is little used except for castings for fittings. Melting the charge in the presence of coke in the ordinary cupola, means not only high-sulphur but high-carbon. The mixture is one in which sprue and malleable scrap predominate; some steel may be used, and enough pig added to bring the silicon to the required point. The mixture as it enters the cupola will run from 0.70 to 0.95 per cent silicon; the total carbon from 2.50 to 2.75 per cent; the manganese in the neighborhood of 1.00 per cent, the phosphorus under 0.18 per cent. The loss in silicon is but little, rarely as much as 0.12 actual, the loss in manganese about 2/5 the original content; carbon will be picked up to an amount that will produce an average of 3.00 per cent in the product, while the amount of sulphur in the product will be a function of the fuel ratio, the quality of the coke, the amount in the original mixture and the size of the scrap. The smaller the scrap the larger will be the gain in sulphur. In

the fittings examined by the author the sulphur averages around 0.25 per cent. While such iron, when annealed at a high temperature, will produce a free-cutting product, and while it is acceptable as a material for fittings, it would show an abnormal structure in sections at all heavy, while it would be low in elongation.

Designing an Air Furnace

The reverberatory, or air furnace is the melting apparatus most used for the production of white iron castings. It is, as is well known, a wasteful apparatus, having an efficiency ordinarily under 10 per cent. As numerous inquiries have been received in regard to its design the following will prove pertinent. Under the assumption that bituminous coal and forced draft are to be used and that the furnace capacity is to be 15 tons, the first dimension to establish and lay-off is the length of hearth, that is, the inside distance between bridge-walls. Theoretically this should be such that the charge will have absorbed all of the heat from the combustible gases just as these leave the hearth on the way to the stack. Such conditions are impractical, for this would imply an exceedingly long, narrow hearth with depth of metal so shallow that it presumably would be oxidized badly long before it became hot enough to pour. Therefore, to obtain practical working conditions, the distance between the bridges must be such that a proper ratio of width, length of hearth and depth of bath must obtain, the former to provide for a workable hearth-size and the latter to avoid excessive oxidation. For this capacity furnace an inside distance between bridges of 22 feet and an inside width of 6 feet 6 inches will provide a mean depth of bath of 7 inches, which will be about right.

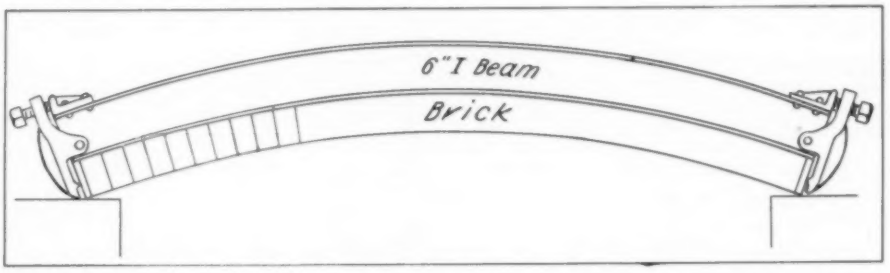


FIG. 2—STANDARD DESIGN FOR A FRAME FOR AN AIR-FURNACE BUNG

The top of the front bridge theoretically should be level with the molten metal, but if this were the case the furnaceman in rabbling the bath to hasten melting of pig still partly solid and protruding above it would splash molten metal into the fire pot. To prevent this the bridge should be some 6 inches higher than the level of the metal after the charge has entirely melted down. The top of the rear bridge should preferably be 3 inches lower than the top of the other. To lay off the hearth bottom, draw a horizontal line 6 inches below the top of the front bridge, which will hit the rear bridge 3 inches lower than its top. Draw another horizontal line 9 inches under this, and between these two lines, and limited by the bridge walls, lay off the bottom on a curve such that its lowest point, locating the tap hole, will be about 8 feet from the front bridge. This is shown in Fig. 1. The curve or slant on each side of this point should have a pitch not much more than sufficient to drain the iron from the hearth, and such that as the metal is withdrawn feathered edges of metal are not pronounced, that is, the average mean depth of metal should be as great as possible when the hearth is full, and as it is being emptied. A tendency is to get the tap hole too near the front bridge. If this is done the brick surrounding the tap hole will wear unduly, owing to the wash of the metal and slag produced by currents induced by the action of the overhead blast used to provide air for secondary combustion.

Next lay off the thickness of the bridge top which should be 15 inches. Theory calls for the level of the coal bed to be flush with the top of the bridge, but if this were done, the forced draft would blow some coal into the hearth and recarburize the bath, which it is desirable to avoid.

For the general character of coal used in the States, it has been found that if the distance from top of bridge to the level of the coal is 15 inches, there is little danger of this happening. This distance also will locate the bottom of the fire door or stoke hole.

The next step to decide upon is the depth of fire bed, bearing in mind the fact that the use of bituminous coal is actually equivalent to the employment of two separate and distinct fuels; one consisting of coke and the other of gas. For this reason it always has been the writer's practice to approach as near to gas producer principles as possible, not only for the sake of economy, but for subsequent uniformity of operations as well. Therefore, in his designs he has provided for a deep bed of fuel. In the case of a thin bed, the burning of the fixed carbon left after the volatile matter has been distilled off, serves to heat the fire pot intensely and locally rather than the hearth where the heat is desired. It has been the writer's effort to discourage this action and bring about as little combustion in the fire pot and as much in the hearth as practically is possible. If the fixed carbon on the grates can be converted into CO, then this combustible gas may be burned in the hearth, and carbon is transferred from a location where its combustion does minimum good to the place where it is of maximum benefit. For this reason, if a thin bed of fire is to be used the precentage of volatile matter in the coal should be as high as possible, while in the case of a thick bed the volatile matter should preferably not exceed 25 per cent.

Secondary Combustion

It happens, also, that through this procedure another thing is accomplished of equal if not of greater importance. Volatile matter is not driven from bituminous coal at a uniform rate. When such coal is stoked on a thin fire consisting of a glowing bed of fixed-carbon or coked-coal at a high temperature, the gas instantly surges from the added coal in great volume. Inasmuch as no means has been found whereby the blast valve for the secondary air can be adjusted to deliver an amount at all times in theoretical proportion to produce complete combustion with the amount of combustible gas passing over the bridge, the following undesirable conditions obtains: The instant the stoker fires, more combustible gas is passing over the bridge than properly can be taken care of by the fixed amount of secondary air, provided the air supply as it should be is fixed for the average amount of combustible gases passing over the bridge from the time the stoker fires until it is time for him to fire again. This state of affairs lasts for a short interval of time, when for some moments there will be about the theoretical proportion of combustible gas and air, after which the air will be increasingly in excess until the stoker again fires. It is plain that if the amount of secondary air must be fixed, the more uniformly the combustible gas is evolved the less serious will be this handicap.

While there appears to be no prac-

tical method of accomplishing this object, the condition can be improved if arrangements are made whereby the fixed carbon of the coal is converted to CO, which will serve to transfer the carbon where its combustion serves but little good to the hearth where it is badly needed. Not only will this occur, but it will, at the same time, better the unbalanced condition referred to, because there will, at all times, be a more constant supply of combustible gas passing over the bridge in a unit of time.

To control the situation still better the stoker should be instructed to fire a small amount of coal at frequent rather than a large amount at longer intervals of time. Since the level of the coal has been placed 15 inches below the top of the bridge, a distance 30 inches lower will give the location for the top of the grate bars, while an additional 30 inches will provide sufficient height for the ash pit. Since the width of the grate is established by the width of the furnace hearth, it remains to determine what should be its longitudinal dimensions. This obviously will depend upon the number of pounds of coal it is essential to burn per square foot of grate per hour. Experience has demonstrated that for this size furnace a grate area of about 26 square feet will meet the conditions required which is a compromise as between economy and speed.

Consequently if 5 feet 6 inches is taken as the length of the grate the area required will be obtained. If this distance is added to the other lengths cited, the total length from inside edge of rear bridge to inside of wall of the fire pot will be obtained.

If this design were being laid out on paper as in Fig. 1, a perpendicular line of indefinite length should be erected at the latter point, the proper length of which will be determined subsequently by its intersection with the roof line. To determine the lines for the furnace roof curve, at a section passing through the longitudinal axis of furnace, it is essential to establish three points only. First, the perpendicular distance above the front bridge; second, the highest point in the roof, which is usually directly over the tap hole; and the last, the distance above the rear bridge. For this capacity furnace the first point should be about 23 inches; the second will depend upon the character of castings to be made, and for average conditions would be 42 inches. If the castings made are light the distance should be greater than if they are heavy for in that case the sprue will occupy more room per ton. The distance for the last point should be about 12 inches. As the melting is chiefly accomplished by reflected heat from the roof, it is desirable to have it as close to the bottom as possible and still admit the charge in the furnace conveniently and rapidly. After locating these three points, on the paper, an easy curve may be drawn through these points with a flexible rule, taking the precaution of bringing the end of the curve that intersects the extreme wall of the fire pot as low as judgment indicates will not prove abnormal, to restrict the space in the fire pot, with the result that combustion will be discouraged in that department as much as possible, and forced to take place in the hearth.

All the inside lines needed for a longitudinal section up to the hearth side

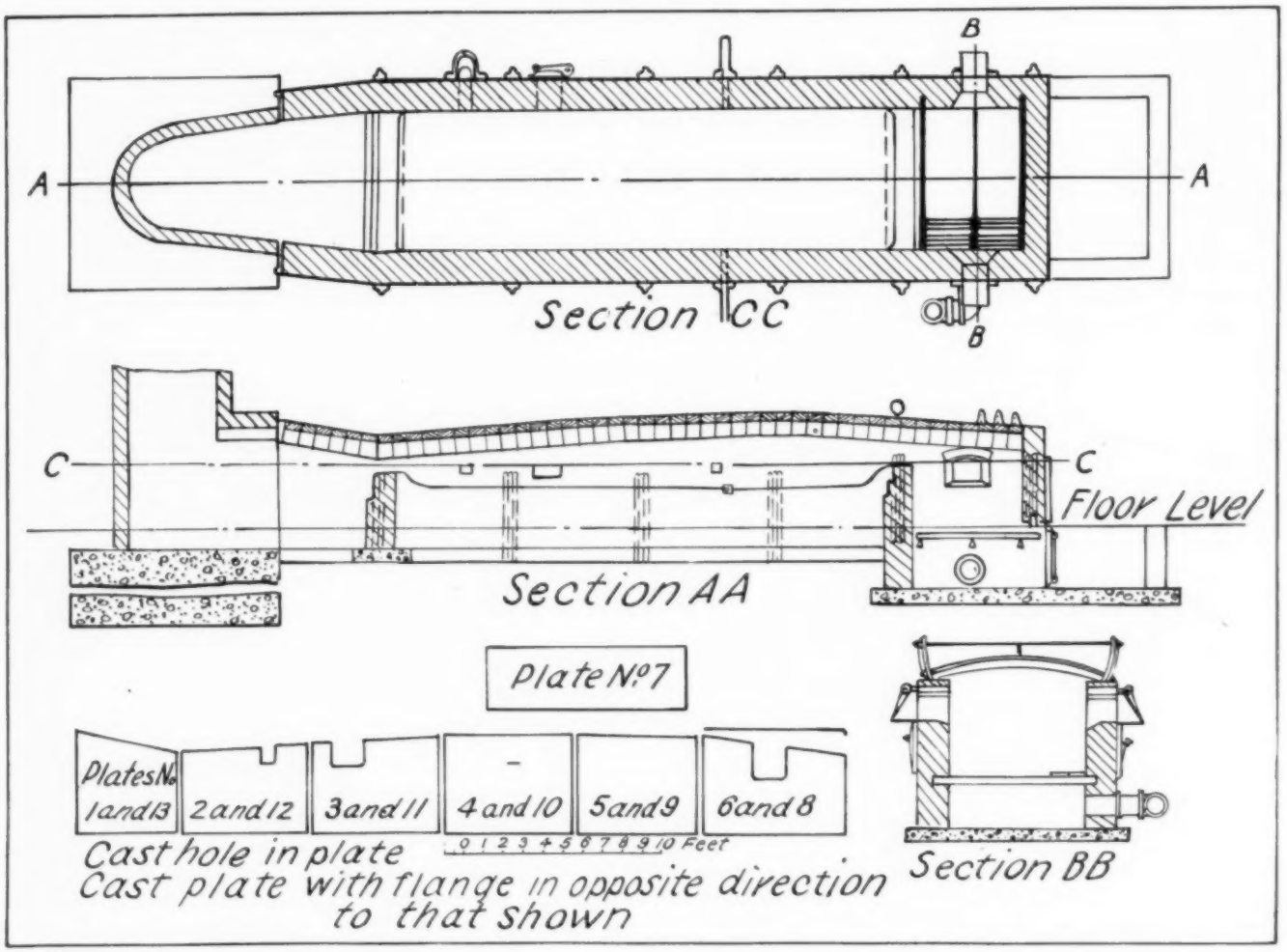


FIG. 3—DETAILS OF CONSTRUCTION FOR A 20-TON MELTING FURNACE FOR MALLEABLE IRON

of the rear bridge wall have been obtained. It will be sufficient if the top of the rear bridge be 12 inches wide, which in the direction of the stack may be stepped off in accordance with usual construction. The distance between the rear bridge and the stack is called the neck of the furnace, and while its length in no way affects combustion, it should be sufficiently long to prevent the rapid burning away of the lining of the stack as it is cheaper to repair the former than the latter. A distance of 10 feet from rear bridge to stack center will be approximately right. Obviously, with forced-draft, the stack requirement need be provided only for what is essential to prevent the smoke from proving a nuisance. The side-wall linings are usually 18 inches thick. The furnace is enclosed by iron plates, held in place by buck stays, conveniently spaced.

Standard Bung Recommended

While many designs of bung-frames are used, the one favored by the author consists of a 6-inch I-beam, bent for a center spring of 8 inches, with clamp castings on the ends, that are hinged at a hole in the lower part of the web by a bolt that goes through this hole and one of equal diameter in the casting as shown in Fig. 2. The part of the casting that extends below the eye-beam to clamp the brick is provided with a knife edge, and a steel plate is placed between it and the first brick for a uniform distribution of pressure. Through this construction a heavy pressure may be applied to the brick that will keep them securely in place. Not only is a strong and stiff bung frame provided, but as the webs are narrow a considerable part of the brick is left uncovered which will allow heat to be radiated off sufficiently fast to prevent damage to the roof. Another good form of frame is shown in the design for a 20-ton furnace. (Fig. 3.)

While for the most part the ordinary fire sand bottom is used in this country, the author favors the brick bottom, which can be made of old bats otherwise would be taken to the dump or ground up for other use. The brick should be laid on edge on a cushion of fire sand about 2 inches deep, and spaced about 5/8 inches apart on all sides. A dry fire sand, having enough impurity to flux tightly with the brick then should be poured into all the crevices. Afterward more sand should be thrown on the surface, and this swept around by a stiff road-cleaning broom, to the end that every crevice is completely and tightly filled with sand.

A bottom laid in this manner may be relied upon to give much longer life than the regular bottom of fire sand.

The tuyeres should be located about a foot in front of the grade bridge and inclined at an angle of about 45 degrees. While the general practice is to use from four to six pipes for tuyeres, the author prefers the continuous type that goes practically across the roof. These deliver a thin sheet of air that cuts and completely mixes with the stream of combustible gases passing into the hearth instead of permitting the air to enter in jets. The ends of this continuous tuyere should be constructed so that the air will not impinge upon the side walls and thus cause erosion.

A direct-connected, motor-driven fan installed at the side of the furnace will prove to be more economical than one that is belt-driven and located at a distant point necessitating lengthy piping, while it is better practice to have a separate fan for the secondary air supply, as through this means both the volume and pressure can be regulated better. About 120 cubic feet of air per pound of coal seems to give good results for under grate supply, rate of oxidation and other factors being considered. About one-third of this amount should be provided for secondary air supply. While only a few of the plants at the present time make use of CO_2 recorder, little by little the wisdom of using this instrument more generally is recognized.

If a deep bed of fire is to be used it is quite essential to have properly designed and spaced grate bars. If the grate does not shed ashes with facility, the stoker shortly will find that instead of a deep bed of coal he has a deep bed of ashes, with the result that little if any CO will be generated. If the bars are too widely spaced, a happening that is less frequent, the bars quickly will be destroyed and trouble will be experienced from clinker with a coal that would not perhaps cause that annoyance under other conditions. The author has designed a grate bar of kite-shaped section, as a stiff bar can be made in this manner that will produce but minimum clogging as compared with rectangular bars of equal depth. It is plain, that as soon as ashes are deposited on such bars, they must either fall through with facility or clog only as far down as 1/3 depth of the bar which is the distance at which the kite section is of maximum width. Beyond this depth the section gets narrower and the space between the bars wider, and consequently the ash must fall free from this point down. The ends of the bars where they rest on the grate bar supports are of rectangular shape, the dimensions depending upon how far apart the bars are to be placed. These ends are proportioned to act in part as spacers. While certain forms of the shaking grate have given satisfaction, their adoption has been slow. It should also be stated that, once the fire pot has been filled, it is a mistake to allow the stoker to disturb it except to level the bed. He seems to be obsessed with the belief that, if he is not continually poking the fire, he is remiss in his duty, in spite of the fact that this method of procedure will result in the formation of clinker, making the conditions worse in a coal that has that tendency.

In some instances where the cost is not prohibitive, oil is used for fuel, and in other cases powdered coal. An average of 58 gallons of oil per ton of iron melted and a ratio of 4.50 of iron per ton of coal used, can be counted upon in the case of good installations, as against an average ratio of 2.5 of iron to one of coal in the case of regular air-furnace practice. The installation for oil is inexpensive as compared with that for powdered coal, unless provision is required to safeguard against strikes or for other causes that would necessitate a large storage capacity. In the case of powdered coal, its adoption by a plant of small capacity would be prohibitive, unless it was the intention to use this system for annealing also. Where conditions warrant, powdered coal is the fuel to use, due to its flexibility; but, if installed, provision should be made whereby it is not essential to run the entire installation in the event that the plant is running on quarter or half capacity.

Will Hold Management Course for Executives

The seventh annual summer session in industrial organization and administration will be held at the Pennsylvania State College, State College, Pa., from Aug. 28 to Sept. 9 under the direction of Prof. Edward J. Kunze assisted by Prof. J. O. Keller and P. P. Henshall of the department of industrial engineering. The course is designed to meet the needs of manufacturers, superintendents, personnel directors, accountants, production managers and all others who pilot the affairs of industry.

Automobile manifolds are to be porcelain enameled by the D. J. Ryan Foundry Co., Ecorse, Detroit, which recently bought from the Ferro Enamel Supply Co., Cleveland, a complete porcelain enameling department. This is believed to be the first installation of this kind for the purpose.

Tentative Specifications for High Test Iron

1—These specifications cover all classes of gray-iron castings which are required to have a high strength, including those generally known as semisteel castings.

2—The tension test will be made only when specified by the purchaser and at his expense.

I—Manufacture

3—The castings may be made by the cupola, or any other approved process.

II—Physical Properties and Tests

4—(*a*) The transverse test specimens (arbitration test bars) specified in Section 6 (*a*), when placed horizontally upon supports 12 inches apart and tested under a centrally applied load, shall withstand a minimum load of

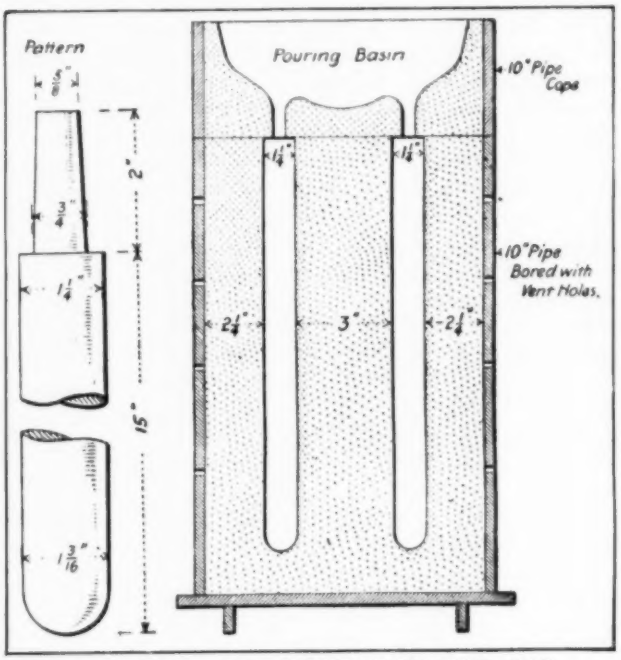


FIG. 1—MOLD FOR ARBITRATION TEST BAR

3800 pounds and deflect under this load at least 0.12 inches at the center.

(*b*) The rate of application of the load shall be such that a central deflection of 0.10 inch is produced in from 20 to 40 seconds.

5—When tension tests are specified, the tension test specimen shall show a minimum tensile strength of 28,000 pounds per square inch.

6—(*a*) *Arbitration Test Bar*—The form and dimensions of the mold for the arbitration test bar shall be in accordance with Fig. 1. The bottom of the bar shall be $\frac{1}{8}$ inch smaller in diameter than the top, to allow for draft and for the strain of pouring. The pattern shall not be rapped before withdrawing. The flask shall be rammed up with green molding sand, a little damper than usual, well mixed and put through a No. 8 sieve, with a mixture of 1 to 12 bituminous facing. The mold shall be rammed evenly and fairly hard, thoroughly dried, and not cast until it is cold. The test bar shall not be removed from the mold until cold enough to be handled. It shall not be rumbled or otherwise treated, being simply brushed off before testing.

(*b*) *Tension Test Specimen*—When tension tests are specified, the tension test specimen shall be turned from any of the broken pieces of the transverse test specimens, and shall conform to the dimensions shown in Fig. 2.

7—(*a*) Two sets of two arbitration test bars each shall be cast from each melt, one set from the first and the other set from the last iron going into the castings. Where the melt exceeds 20 tons, an additional set of two bars shall be cast for each additional 20 tons or fraction thereof. In case of a change of mixture during the melt, one set of two bars shall also be cast for every mixture other than the regular one. Each set of two bars shall be cast in a single mold.

When a large casting is made for which test bars are required, the test bar shall be cast from the same ladle of iron used to pour the casting. If two ladles are used for pouring the casting, the iron for the test bars shall be poured from a ladle of iron caught between the pouring of these two ladles. In either case the test

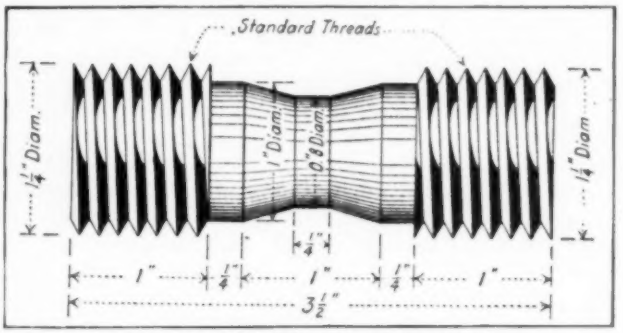


FIG. 2—TENSION TEST SPECIMEN
ADD WITHSTANDS SHORT EXCESS CURRENTS

bars shall be poured at as near as possible the same temperature at which the casting is poured.

(*b*) All arbitration test bars cast shall be tested as specified in Section 4 (*a*).

8—One arbitration test bar of each set cast shall conform to the requirements specified in Section 4 (*a*) otherwise the castings represented by such bars shall be rejected.

III—Workmanship and Finish

9—The castings shall be true to pattern, and free from gas holes, cracks, flaws and excessive shrinkage. In other respects they shall conform to whatever points may be specially agreed upon between the manufacturer and the purchaser.

IV—Inspection

10—The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the castings ordered. The manufacturer shall afford the inspector without charge, all reasonable facilities to satisfy him that the castings are being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Foundry Material Tests Set

American Society for Testing Materials Gives Marked Attention to Castings Manufacturing Industry—Proposes Tentative Specifications for Pig Iron and High Test Cast Iron

SPECIFICATIONS for castings and foundry materials assumed an important part in the proceedings of the American Society for Testing Materials held at the Chalfonte-Haddon Hall notel, Atlantic City, N. J., June 26 to 30, 1922. Growth of the society was indicated by a membership of 3030. The total registration was the highest on record, 743. President C. D. Young in his annual address spoke of the growing importance of the specications of the society which is indicated by the fact that $18,000 of its revenue last year was secured through the sale of its literature. He also reported that the executive committee is considering ways and means of further circulating the *Proceedings* of the society in foreign countries so that American standards may become more generally known. Following the action of the American Foundrymen's association at Rochester, committee *A-3* passed a resolution recommending that the executive committee authorized committee *A-3* to co-operate with representatives of other nations in the formulating of views regarding testing of and specifications for cast iron.

Work accomplished during the past year by committee *B-2* on Nonferrous Metals and Alloys was recorded by a lengthy report of this committee read at the opening session Tuesday morning by William H. Basset. This committee proposed tentative methods of chemical analysis of bronze bearings metals and also tentative methods of chemical analysis of brass ingots and sand castings both of which were adopted by the meeting. The report cited that three of the society's standard methods, namely, chemical analysis of manganese bronze, chemical analysis of gun metal, and battery assay of copper, have been accepted as tentative American standards by the American Engineering Standards committee. As an appendix to the report John J. Freeman Jr., read a paper showing the results of tests made by the U. S. bureau of standards to determine the physical properties of the twelve white bearing alloys which have been adopted as tentative by the society. These tests show that the lead base alloys in general have lower compressive strength and that the presence of lead in an alloy causes more repid softening with increasing temperature. His report also showed that the alloys made under commercial conditions have in general at normal temperatures a higher brinell hardness than the alloys prepared from pure metals under laboratory conditions.

Officers Elected

At the annual meeting of the American Society for Testing Materials held in Atlantic City, N. J., June 27 the following officers were elected: President, George K. Burgess, chief of division of metallurgy, United States bureau of standards, Washington; vice president, William H. Walker, Professor chemical engineering, Massachusetts Institute of Technology, Cambridge, Mass.; members of executive committee, D. M. Buck, metallurgical engineer, American Sheet & Tin Plate Co., Pittsburgh; W. M. Corse, division of research extension National Research Council, Washington; Dr. William K. Hatt, director laboratory for testing materials, Purdue university, Lafayette, Ind; J. R. Onderdonk, engineer of tests, Baltimore & Ohio railroad, Baltimore.

Consider Foundry Materials

Subjects of vital interest to the foundry industry were discussed at the afternoon meeting on Tuesday when reports of committee *A-3* cast iron and committee *A-7* on malleable castings were read. Previous to the report by the committee on Cast iron, Richard Moldenke read a paper prepared by William R. Webster in which he calls attention to the fact that there are no definite statements in the society's specifications for pig iron which would guide the foundryman in making light castings, medium castings heavy castings, or malleable iron, and suggests that the average chemical composition of iron used for each weight of castings be decided upon, taking into account the different foundry methods in use for such work. Dr. Moldenke in discussing this paper said that the foundryman should know what chemical composition he desires in his pig iron and the specification should be necessary only to enable him to obtain the composition he desires.

In a written discussion of this paper prepared by H. V. Wille attention is called to the fact that the composition of castings of the same weight varies considerably according to the use to which they are to be put and cites the difference in composition of locomotive cylinders from other castings of the same cross section.

The specifications for foundry pig iron proposed as tentative by Dr. Moldenke, as chairman of committee *A-3*, are a modification of the present standard specifications and give the limits of variation of each element from the amount specified in the order. As they stand they may be used for pig iron, gray-iron, malleable or steel castings. Objection was made to them by a number of steel foundrymen who claimed the limits of variation are too wide for pig iron to be used in the manufacture of steel castings, but the specifications finally were adopted as tentative by the meeting with the understanding that committee A-3 will consider changes in the specification to make them more suitable to steel and malleable iron foundrymen before the meeting next year when they may be adopted as standard.

New tentative specifications for chilled cast iron wheels as proposed by committe *A-3* were adopted. In speaking of these specifications J. C. Ramage a member of the committee said that at the meeting last year the allowable limit for phosphorus had been discussed and that during the year a number of tests had been made to determine whether phosphorus up to 0.4 per cent is detrimental to the wheel. As the objection to phosphorus was that it tends to cause the wheels to crack under high temperatures, repeated thermal tests were made on 25 wheels. These wheels were subjected to the regular thermal test and allowed to cool until the next day when another thermal test was made. As only one wheel broke after twenty tests had been made on each wheel, and this wheel was of low phosphorus iron it was decided to omit the statement in the specifications that it is desired that the phosphorus content shall not exceed 0.3 per cent. Mr. Ramage also called attention to the increased weight of

Tentative Specifications for Foundry Pig Iron

I—Manufacture

1—The pig iron shall be clean foundry pig iron, as free as possible from an excessive amount of dross and sand, and may be either sand or machine cast.

II—Chemical Properties

2—(*a*) The pig iron shall conform to the chemical requirements specified by the purchaser at the time of purchase, with the following permissible variations from the specified percentages:

Element	Variation from Specified Percentage
Silicon	0.25 per cent above and below
Manganese	0.20 " " " "
Phosphorus	0.15 " " " "
Sulphur	not over specified percentage
Total carbon	not less than " "

(*b*) The percentages specified for phosphorus and manganese may be used as maximum or minimum figures, but unless so specified they shall be considered to be subject to the variations given above.

III—Sampling and Analysis

3—(*a*) In sampling, each carload, or its equivalent, shall be considered as a unit.

(*b*) One pig shall be taken to every four tons in the car, and they shall be so chosen from different parts of the car as to secure, as nearly as possible, a sample representing the average quality of the iron.

(*c*) The pigs thus taken shall be sampled by drilling so as to fairly represent the composition of the pigs as cast.

(*d*) An equal weight of the drillings from each pig shall be thoroughly mixed to make up the sample for analysis.

4— It is recommended that analyses be made in accordance with the Standard Methods of Sampling and Chemical Analysis of Pig and Cast Iron (serial designation: A 64) of the American Society for Testing Materials.

IV—Inspection and Rejection

5—In case of dispute, the sampling and chemical analysis shall be made in accordance with the Standard Methods of Sampling and Chemical Analysis of Pig and Cast Iron (serial designation: A 64) of the American Society for Testing Materials by an independent chemist, mutually agreed upon, if practicable, at the time the contract is made, whose decision shall be final. The cost of such re-sampling and re-analysis shall be borne by the party in error.

6—All pig iron which fails to conform to these specifications shall be subject to rejection.

Appendix

In using these specifications it is not advised that all five elements be specified in all contracts for pig iron, but it is recommended that, when these elements are specified, the following percentages be used, and for convenience the accompanying code is endorsed:

Silicon Per Cent	Code	Sulphur Per Cent	Code	Total Carbon Per Cent	Code	Manganese Per Cent	Code	Phosphorus Per Cent	Code
1.00	La	0.04	Sa	3.00	Ca	0.20	Ma	0.20	Pa
1.50	Le	0.05	Se	3.20	Ce	0.40	Me	0.40	Pe
2.00	Li	0.06	Si	3.40	Ci	0.60	Mi	0.60	Pi
2.50	Lo	0.07	So	3.60	Co	0.80	Mo	0.80	Po
3.00	Lu	0.08	Su	3.80	Cu	1.00	Mu	1.00	Pu
3.50	Ly	0.09	Sy	(Minimum)		1.25	My	1.25	Py
(0.25 allowed either way)		0.10 (Maximum)	Sh			1.50 (0.20 allowed either way)	Mh	1.50 (0.15 allowed either way)	Ph

Illustration of the use of above coding: The word Li-se-ca-mo-pi indicates

Silicon	Sulphur	Carbon	Manganese	Phosphorus
2.00	0.05	3.00	0.80	0.60

with variations as allowed.

Percentages of any element specified half way between the above shall be designated by the addition of the letter *X* to the next lower symbol.

Example—PeX indicates phosphorus 0.50, with allowed variations (0.15) up and down.

the tup in the drop test, which is now required to be 250 pounds.

Robert Job said that a weight of 250 pounds for the tup is too light and cited tests made by the Lehigh Valley railroad during the past year in which a 400-pound tup was used, dropping 8 feet on the 650-pound wheel, 9 feet on the 700-pound wheel and 11 feet on the 750-pound wheel. These wheels stood on average of 6, 8 and 6 blows, respectively, before breaking.

Tests were reported by J. R. Onderdonk in which wheels stood 200 blows of a 300-pound weight dropped 15 feet. In view of tests being made it was said to be probable that the weight of the tup would be increased in the specifications next year.

Specifications, on high test gray iron castings, proposed by committee *A*-3 requiring a tensile strength of 28,000 pounds per square inch and a traverse strength in the arbitration test bar of 3800 pounds were accepted as tentative.

The report of committee *A*-7, on malleable castings, read by H. E. Diller, chairman, was accepted including proposed changes of the specifications for malleable iron. These changes included raising the requirements for tensile strength from 45,000 pounds per square inch to 50,000 pounds, and the elongation from 7.5 per cent in 2 inches to 10.0 per cent. The dimensions of the test bar are also changed to those given in the illustration accompanying the malleable report.

Steel Casting Specification

Tentative specifications for carbon-steel castings for railroads were proposed by committee *A*-1 on steel and were adopted. A new recommended practice for heat treatment of carbon-steel castings, to be substituted for the present recommended practice, was proposed by committee *A*-4 on heat treatment of iron and steel and accepted. J. H. Hall, secretary of this committee, said an investigation now is being made to determine the desirability of annealing iron chain at intervals, and that the sub-committee on heat treatment of alloy steels is reviewing the existing specifications of the society with a view to considering any possible changes involving heat treatment. Important revisions of the standard methods of chemical analysis of plain carbon steel and of the standard methods of chemical analysis of alloy steels were proposed by this committee and adopted as tentative. Revisions in the automobile carbon and alloy steel, standards were proposed and adopted as tentative for one year. It was recommended and accepted that the tentative standards for electric cast steel anchor chain should remain tentative for another year.

The term "elastic limit" when applied to annealed cast steel has little meaning, as this metal behaves as a plastic rather than an elastic material, according to a paper on Tensile Properties of Steel Castings by Lawford H. Fry. This paper presented the results of some 600 tests from seven manufacturers, grouped into

two series. In the first series the tensile properties as usually determined were compared to show the relation between strength and ductility, and the relation between the yield point and the elastic limit determined by the method for forgings adopted by committee *A*-1 on steel. In the second series methods of greater precision than are applied in commercial testing were used to compare the so-called true elastic limit with the yield point. In the second series, stress-strain curves were plotted with the aid of a Berry strain gage to measure the elongation. The uncertainty in the determination of the elastic limit is due largely to the fact, said Mr. Fry, that there is no constant proportion between elongation and stress.

H. F. Moore, in commenting on this paper, said it was clear that no single method of test could be adopted as standard for castings, rolled products and forgings. They do not lend themselves to the same method for best results, so that the selection of the method should depend on the particular application. J. R. Onderdonk said too much reliance should not be placed upon the results obtained from a small test-piece. Even when the test-piece shows up well, a large forging or casting may develop strains that will have disastrous results.

Announcement was made that the executive committee had received a recommendation from committee *E*-6 on papers and publications asking it to give consideration to the desirability of holding two meetings a year hereafter, one, as usual, in June, for the consideration of standards and tentative standards, and a midwinter meeting, which would be a technical session for consideration of papers on testing and research.

An instance of co-operation between the great technical societies is the appointment of G. K. Burgess and Richard Moldenke as the society's representatives on the joint molding sand research committee which was organized under the joint sponsorship of the engineering division of the National Research council and the American Foundrymen's association.

Since this year marks the 25th anniversary of the society, the address of the retiring president, C. D. Young, was written in appropriate vein. It detailed the history and achievements of the society. When it had its inception in 1898, there was little appreciation of the benefits of standardization, uniformity of testing and a common nomenclature. Since then, the society has produced standards covering nearly all of the important materials generally used in engineering construction and in manufacturing.

A novel feature of the program was a symposium on impact testing of materials which occupied all of the Wednesday evening session. This symposium, the result of two years of planning, comprised a complete presentation of American practice in this important branch of testing.

H. L. Whittemore opened the symposium with a resume of the history of impact testing, together with a bibliography of the subject. His remarks were only of a general character but his complete paper, which was not preprinted, will appear in full in the transactions. Machines and test specimens used in impact testing were detailed by D J. McAdam Jr., Thomas R. C. Wilson and Earl B. Smith. In their papers, these authors described the various types of machines and the test specimens employed in impact testing of metals and other materials. In the discussion of these papers, Prof. W. K. Hatt described the original machine he developed and he told of early methods of impact testing. Lawford H. Fry, described the impact testing of full-sized axles and shafts.

The third section of the symposium was the presentation of papers by C. E. Margerum, Armin Elmendorf and H. F. Moore on the measurement of impact. In discussion, Earl B. Smith pointed out that there is little data in this country on the subject, and he said that the European data were much more complete.

Previous to the meeting on Thursday afternoon in which the reports of the committees on coal and on coke were given, A. C. Fieldner, who was chairman of the committee on coal, was elected chairman of the committee on coke and re-elected chairman of the coal committee.

Malleable Iron Report

PROGRESS in the betterment of the iron used in malleable castings is recorded by the specifications of this society. Specifications were originated in 1904 and no changes were made for 11 years. In 1915 the first revision was made. Four years later, in 1919, the requirements were materially increased. The tensile strength requirement was raised from 38,000 pounds per square inch to 45,000 pounds per square inch, and the requirements for elongation was raised from 5 per cent in 2 inches to 7.5 per cent in 2 inches. Malleable foundries have now been working to these specifications for three years and at a meeting of Committee A-7, held in Cleveland on April 3, it was decided that malleable iron could be made commercially with still better physical properties. In reference to the question of rejection according to Section 6 (*b*) of the present specifications, which would cause the rejection of an oven of castings if the test specimens representing that oven failed, perhaps on account of flaws and therefore not really representative of the castings, the committee decided to recommend a change so that retests could be made at the discretion of the inspector.

Your committee, therefore, proposes the following revisions in the Standard Specifications for Malleable Castings (*A* 47-19), for publication as tentative:

Section 3—Change to read as follows by the addition of the italicized figures and the omission of the figures in brackets:

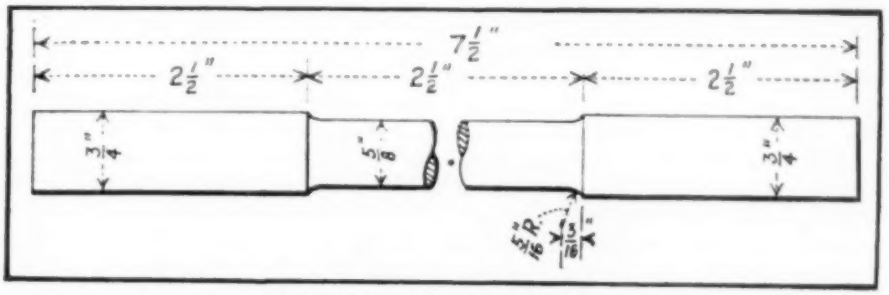


FIG. 1—MALLEABLE SECTION

"The tension test specimens specified in section 5 shall conform to the following minimum requirements as to tensile properties:

Tensile strength, lb. per sq. in.	[45,000] 50,000
Elongation in 2 inch, per cent..	[7.5] 10.0"

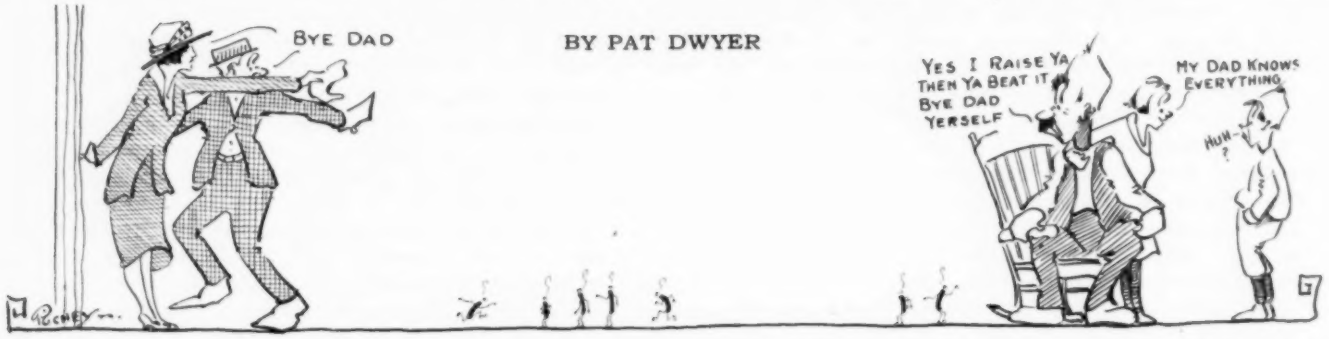
Section 6 (*b*)—Add a sentence to read as follows:

"In case one of the retest specimens contains a flaw which results in the failure of the bar to meet the specifications, at the discretion of the inspector additional test specimens from the same oven may be tested, or test specimens may be cut from castings."

It is further recommended that the standard test specimen be modified to conform to the dimensions shown in Fig. 1. As may be noted, this changes the total length of the test specimen from 12 inches to 7½ inches and the gage length from 4 inches to 2 inches.

Bill Discusses Pulley Molding Problems--II

BY PAT DWYER



OUR older children long since have passed the stage where they considered my advice or suggestions of any assistance in their home work. However, a few of the younger children still do me the honor of consulting me on disputed points and in that way my interest is maintained to a certain extent in subjects which at one time I heartily disliked. One of the most pleasant features in connection with securing my first job was the reflection that my studying days were over and that I never need open a book again. I did not look on the inside of a school book for several years and probably never would have looked at one except for the fact, previously referred to, that I was regarded in the role of an oracle, you know, Paw knows everything.

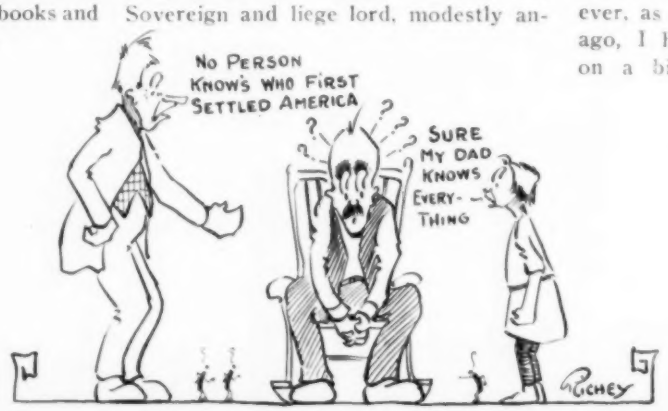
We were discussing a nice point the other night touching on the discovery of America and the probable origin of its first inhabitants when Bill came in. He claimed that the present educational methods leave much to be desired. Children are stuffed with a mess of concrete facts and figures, purely a memory test and no real attempt is made to cultivate the faculty of thinking and reasoning. He was willing to concede that a certain amount of catalog knowledge is necessary, but he felt that more attention should be paid to developing the pupil's ability to think than to stuffing his mind with material filed for reference in books and libraries all over the country.

"For instance," said he, "consider that question you were discussing when I came in. No person knows who first settled America, where they came from or where they went from here. One man's guess is as good as anothers. Evidence of a Toltec civilization 4000 years before Christ, ruins of Uxmal near the city of Merida in Yucatan, the discovery of innumerable pieces of sculpture resembling Egyptian work of the time of the Pharaohs, all lend an air of credence to the claims put forward at various times by learned authorities to the effect that Mexico was settled by the descendants of Naphtuhim, son of Mizraim and grandson of Noah who migrated from Egypt to Mexico; that the ten lost tribes of Israel wandered across the narrow neck of land connecting Asia with America at one time and finally strayed to the promised land and that the country first was settled by the Malays and is the cradle of the world's civilization.

"Then we have heard the story of Lief the Lucky and Eric the Red, swash-buckling, hairy sea dogs according to all accounts who came over some time in the 10th century to take a look at the country. Apparently their tickets did not include stop over privileges along the line of the Chicago, Milwaukee and St. Paul and therefore their impressions of the country were not so favorable as those of their descendants who covered the same route in later years. Columbus discovered the country for the Spaniards. Jacques Cartier did the same for the French and John Cabot sailed out of Bristol on a fine summer's day and when he returned he marched to London, pulled his forelock before his Sovereign and liege lord, modestly announcing that he had added another continent to his majesty's dominions.

"Then the Pilgrim fathers arrived in their private boat and landed on Plymouth Rock and this event seems to have constituted the official opening of the country. Quite a number of people have oozed in since that time, but history makes no particular mention of the fact and in an off hand opinion on the subject based on what I see and hear and read, I should say that when the next discoverer arrives he will feel perfectly at home no matter from which port on the seven seas he hails originally.

"In company with several thousand foundrymen I spent the week of June 5 in Rochester, N. Y. I saw some remarkable sights and heard some still more remarkable stories, but the feature that impressed me most was a parade of colored citizens marching down one of the principal streets on the afternoon of the day we left for home. I wanted to stand on the curb and watch the parade from begining to end, but the Missus wouldn't listen to any proposition of that character. 'If you wish to stand there looking like a goat peeping over a fence,' she said, 'you may do so, but I certainly have no intention of being an accessory before, during, or after the performance.' She started off in the general direction of the railroad station and—well, you know how it is—I did not see much of the parade. However, as I started to tell you a minute ago, I had time to read the message on a big white placard attached to the back of one of the automobiles in line. It stated: 'Did You Know That African Negroes Had Settled in America Before the Time of Columbus?' Well, there y'are. 'Before Columbus' is rather vague, it might



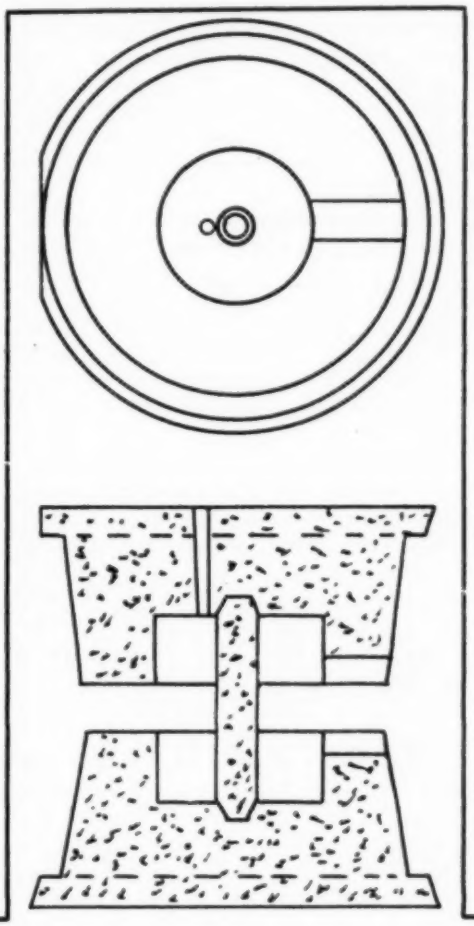
STARTING AN ARGUMENT DOES NOT SETTLE A QUESTION

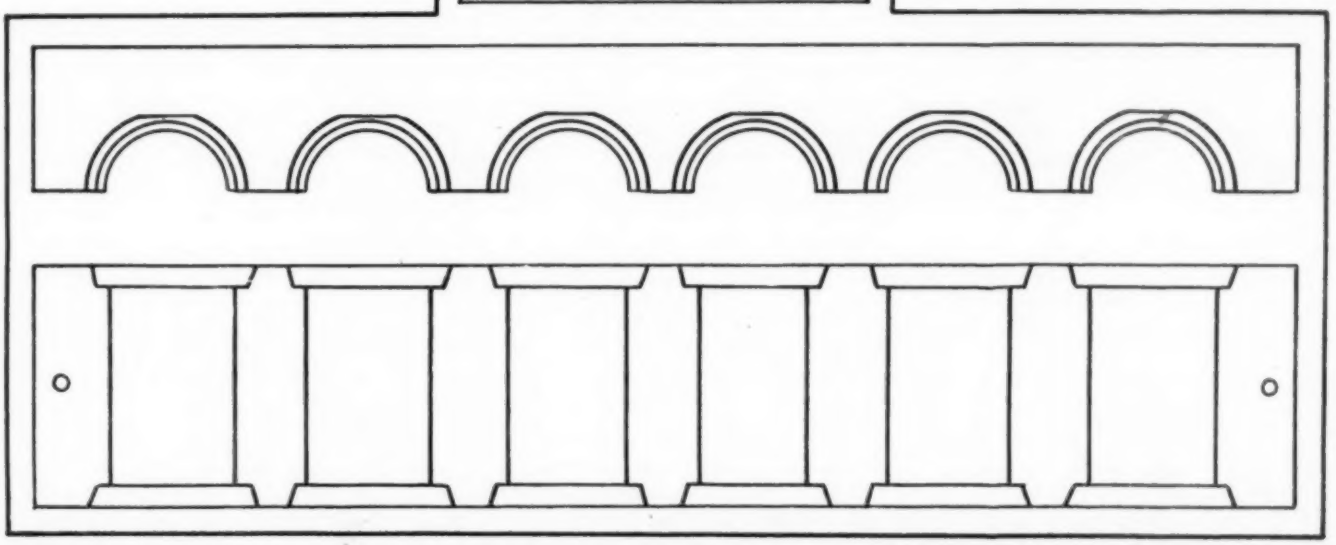
mean the year before, or, it might mean 1000 years before; but no matter how you look at it, the statement seems to indicate that our colored fellow citizens have a priority claim on this continent and when it comes to tracing genealogical trees and all that kind of thing, they are the real original first families. I have not investigated the subject owing to 14 good and sufficient reasons. The first is that I am not interested and do not care whether the country was discovered by Pontius Pilate or Brian Boru and the remaining 13 reasons really are of no consequence. I have no doubt that if a person were to delve into the subject he would find just as much evidence to support one legend as he would find supporting any of the others. Events have a wonderful faculty for becoming distorted in the course of a few hundred years and the spectator's opinion is influenced to a remarkable degree by the first pair of historical spectacles through which he is privileged to gaze into the past. Events that are minimized by one party to a controversy are magnified by the second. There is no such thing as impartial history. This condition always has obtained and in all probability always will, world without end. Amen.

"Laying generalities to one side and considering a single concrete case you will find foundrymen defending certain methods, for no better reason than that they always have employed them. For the same reason they condemn methods employed by others, even though they never may actually have seen them in practice. In many instances one method may be as good as another, but every foundryman has his pet ideas, hobbies and prejudices and usually he is willing to defend them against all comers. Recently we were discussing pulley molding and since that time I have collected some dope and started to arrange it with a view to writing a description of how pulleys are molded under practically all conditions.

"One of the best rigs I ever saw for making small pulleys on a production basis was installed by a friend of mine in a gas engine shop in the middle west. I would tell you his name, but he is one of those lads who hates notoriety, so I just shall say that his first name is Red and you can take three guesses on the remainder. The rig may be described as a semi-permanent mold inasmuch as a solid piece of cast iron forms the exterior of the mold and the interior is formed with dry sand cores. Probably the idea will be developed in time to a point where some form of collapsible metal core may be employed, but up to the present the sand core has been necessary to provide contraction allowance. The iron poured into these pulleys runs over 3.00 per cent silicon and although the iron mold densifies the metal in the casting it does not chill it as the term is understood in the foundry. The pulleys are about 6 inches in diameter with a 6-inch face and are machined on the face. On account of the accuracy and rigidity of the iron mold in which they are cast, the machining allowance is reduced to a minimum. I am not a machinist and therefore hesitate to say positively, but I think they are finished by grinding.

"The device consists of a heavy permanent base mounted on four legs about 12 inches high. The legs merely are provided to support the molds at a convenient height for pouring. The base is planed on the upper side and supports two heavy castings accurately machined to form the outside of six pulley molds. One half of this multiple mold is attached firmly to the base while the other may be moved back and forth in a straight line by a suitable lever and toggle arrangement. The movable half of the mold may be thrown back about 10 inches thus according ample room for removing the castings after they are poured. Slides on the base plate and dowel pins in the half molds insure that the halves are properly assembled each time after the castings have been ejected. In addition to forming the interior of the pulley the





BELOW—ELEVATION AND PLAN OF HALF MOLD—ABOVE—SECTION AND PLAN VIEW OF ASSEMBLED MOLD

core forms the edge of the casting top and bottom by a suitable shoulder which fits into a recess on the mold.

"In practice, the mold is opened and all loose sand is blown away with an air hose. The core, in three parts, top, bottom and center stock core, is assembled and slid into place. The shoulder on the bottom of the core automatically locates the core in its proper relative position to insure an even thickness of metal in the rim of the pulley. The six molds are cored in the foregoing manner and then the movable half of the mold is moved forward until the facing surfaces touch each other. The throw of the toggle lever is adjusted in such a manner that it serves as a lock to hold one half of the mold tightly against the other. Corresponding gaps in the two halves of the body core at the line where they form the web in the center of the wheel, are provided to furnish extra metal at the point where a hole is tapped later and threaded for a set screw to hold the pulley on the shaft. The top and bottom cores each are made with a flat space along the shoulder to serve as a guide in locating them in the iron mold. Since both cores are made in the same box it is apparent that unless some suitable mark is provided the half circular gaps previously referred to might not come in line when one part of the core is inverted over the other. The three parts of the core may be assembled on the bench and placed in the mold as a unit, or they may be placed in the mold one piece at a time. Thus the bottom sections may be set first and then the two halves of the mold may be brought together. Afterward, the center core may be set followed by the top or covering core. A bar raised above the movable half of the mold, but attached to it firmly by a bracket at each end, is provided with 6 screw bolts, one over each pulley mold. After the mold is assembled one of these bolts attached to a small round plate is screwed down and holds the core in place while the mold is filling with iron. Each pulley is poured through a single small pop gate extending through the top core and connecting with the hub. The machine is operated by an ordinary laborer who experiences no particular difficulty in pouring 300 pulleys during the afternoon's heat.

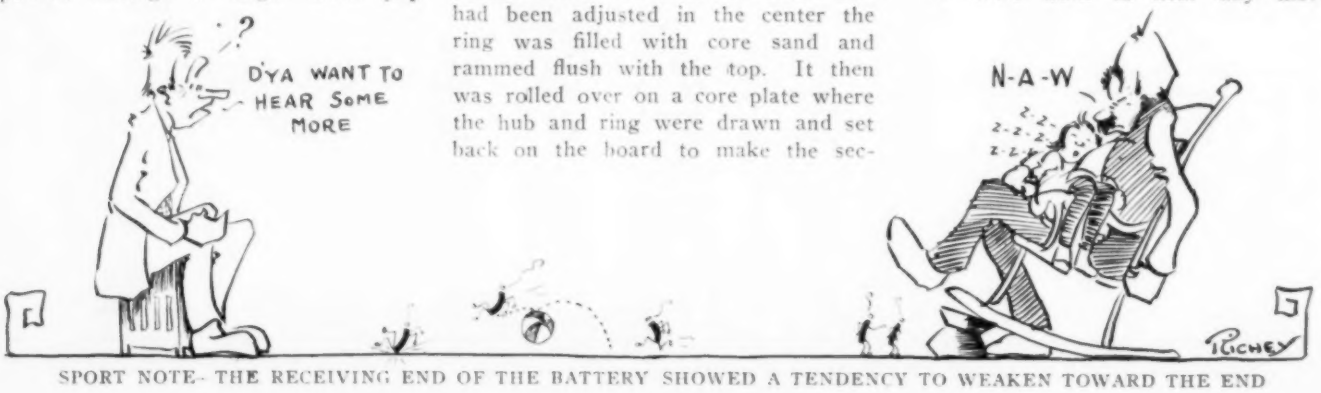
"Owing to the lightness of the casting and the heavy section of the mold the heat is absorbed and radiated so rapidly that the mold never becomes unduly heated. For the same reason it has been found unnecessary to coat the interior face of the mold with any preparation. The face of the mold is rubbed with an oily rag before it is assembled the first time but that merely is a precaution in the event that any atmospheric moisture has condensed upon it since the preceding day, or that it may have been splashed with water while the night gang was wetting down the surrounding sand heaps. The gas from the bottom half of the core passes off through a hole in the base plate and since the top half of the core also serves as a covering. core the gas from that half of the core is free to escape upward. The small round plate on the end of the holding down bolt presents no real obstacle since it only covers part of the surface.

"As a contrast to the foregoing let me tell you how I made an emergency job pulley 10 inches diameter, 22 inch face and all the pattern equipment I had was a piston ring pattern and a loose hub from a small pulley pattern. The ring pattern was 12 inches deep, but as that only meant a little extra cutting in the machine shop I decided to draw it to 25 inches in the mold and make two full size dry sand cores for the interior. The cores would each be 12 inches high and by keeping them 1 inch apart in the center the entire height would be the same as the mold, 25 inches. The 1-inch space between the cores served as a web to connect the hub with the rim of the wheel.

"The dry sand cores were made first so that they might be ready by the time the mold was finished. The piston ring pattern was set on a planed board and after the loose hub had been adjusted in the center the ring was filled with core sand and rammed flush with the top. It then was rolled over on a core plate where the hub and ring were drawn and set back on the board to make the second core. A 1½-inch stock core also was made the proper length to extend through the hub of the wheel and in addition to these cores, four pieces of 1½-inch core each 1 inch long were made. These four little cores were designed to separate the top and bottom core at the center line of the pulley and provide a web 1 inch thick connecting the hub with the rim. The cores were placed in the oven and then the mold was made by striking a flat bed on a shallow drag. The pattern was set on this bed, surrounded by four drags, put on one at a time and rammed full of sand until the pattern had been drawn to a height of 25 inches above the bed. The inside of the pattern was not filled with sand. It was left open and only the space between the outside of the pattern and the flask was rammed full. After the pattern was removed, the mold was cleaned, blacked and made ready for the cores. The bottom half of the core was lowered until it rested on the sand bed in the bottom of the mold. The center core then was set and also the four small distance pieces each 1½-inches diameter, 1-inch high. The upper half of the core then was lowered into place until it rested on the center core and the four small cores. A flat iron strap was placed on top of the core. It extended from side to side of the flask and was held at each end by the clamps employed for holding the parts of the flask together. The rim of the pulley mold was left open at the top and the iron was poured in through a small pop gate on the hub.

"Now, as I said, that was an exceptional case and of course would not apply where any number of castings were required. However, the idea may be adapted to various size wheels, and for that matter, other jobs of a some what similar character under emergency conditions. Small pulleys in modern practice are made either from split patterns mounted on roll-over machine or on machines in which the table is stationary and the ring pattern strips through the plate."

"I don't want to hear any more



SPORT NOTE- THE RECEIVING END OF THE BATTERY SHOWED A TENDENCY TO WEAKEN TOWARD THE END

about them tonight," I said. "The first thing I know you will be trying to prove that a native of Sierra Leone, Senagambia or the Congo Free State introduced the art of pulley molding into America."

"Well," said Bill "I don't know if the colored man made the first pulleys cast in this country, but I do know that at the rate the white molders are being race suicided out of existence the colored man stands a mightly fine chance of making all the pulleys required in the future."

Graphite Production Low in 1921

Sales of domestic graphite in 1921 showed a decrease of 74 per cent in quantity and 85 per cent in value in comparison with 1920. This large loss both in quantity and value brought production to the worst condition in the graphite industry shown by the records of Geological survey. Over-production in preceding years was the main cause of this situation. Manufacturers were overstocked with crucibles and with raw material, both foreign and domestic, and large stocks of domestic flake graphite were on hand at the mines. The production of graphite over the period of years from 1915 to 1921 is set forth in the following table:

DOMESTIC GRAPHITE SOLD
1915-1921

Year	Amorphous Short tons	Crystalline Short tons	Total Short tons
1915	1181	3537	4,718
1916	2622	5466	4,088
1917	8301	5292	13,593
1918	6560	6431	12,991
1919	3379	4043	7,422
1920	4694	4816	9,510
1921	1842	595	2,437

The sales of crystalline graphite in 1921 showed a decrease of 88 per cent in quantity and 87 per cent in value as compared with 1920. This graphite was produced by only five firms operating in four states. New York led, Texas ranked second, and California third. Eight of the 13 firms that reported sales in 1920 stated that their mines were idle in 1921.

In 1921 the amorphous graphite sold decreased 61 per cent in quantity and 58 per cent in value in comparison with 1920. The average value per ton sold by producers in 1921 was $11.32 which was 72 cents more than the average in 1920. However, this increase in value does not mean that the price was higher in 1921 than in 1920 for it has always been larger sales which have brought higher prices.

Graphite is manufactured by the Acheson Graphite Co. at Niagara Falls, N. Y. The figures in the following table represent the manufactured graphite produced from 1917 to 1921 inclusive.

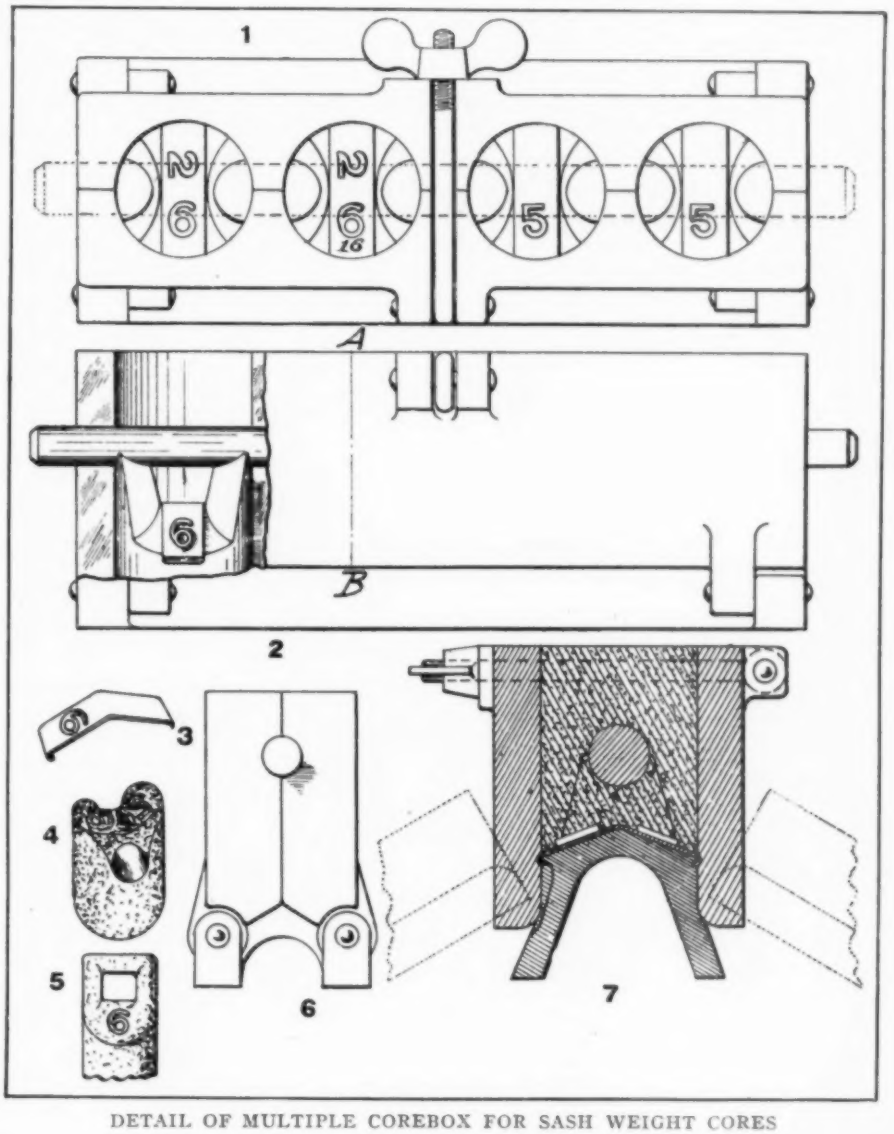
MANUFACTURED GRAPHITE PRODUCTION
1917-1921

	Tons
1917	5232
1918	4591
1919	4081
1920	3195
1921	2944

Core Forms Square Eye in Sash Weights

Patents have been granted DeVed Bros., Inc., Baltimore, for the multiple corebox shown in the accompanying illustration, designed to form the eye and imprint the weight on cylindrical castings intended for window weights. The core is in the form of a plug adapted to close the top of the sand mold in which the weight is cast; it forms the eye which receives the cord and incidentally forms the entire top of the weight. In the illustration the corebox is arranged for making four cores at a time, but this arrangement is not arbitrary. The corebox is made up in the main of three parts. Two swinging sides which open and close like a pair of tongs and a base on which the sides are hinged. A center rod or bar, detachable, and which may be pulled out through either end of the box before the clamp is loosed, serves to form the bar over the eye in the casting. The upright projections forming the bottom of the coreboxes also are used to support the number plates by which the number corresponding to the weight of the casting is placed on the core and later transferred to the castin.

Fig. 1 is a plan view of the assembled corebox; Fig. 2 is a side elevation with part of one end cut away to show details of parts forming the eye; Fig. 3 detail of the plates used to form the numbers; Fig. 4 shows one of the cores; Fig. 5 the eye end of one of the castings, Fig. 6 is an end view of the corebox closed; Fig. 7 is a section on line *AB*, Fig. 2.



DETAIL OF MULTIPLE COREBOX FOR SASH WEIGHT CORES

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Who Will Make the Castings

FOUNDRYMEN appear to hold widely divergent views while discussing the future of the industry or the manner in which castings probably will be produced, say, 20 or even 10 years hence. While it is true that castings primarily are made to sell, it also is true, especially in many of our large casting plants at the present time, that the man responsible for their production, has no voice in the final disposition of the castings. Time was when a foundry manager bought his supplies, contracted with his customers on prices and time of delivery and arranged terms of compensation with his employes. He controlled every move and operation in the sequence between placing the order and delivering the goods. In common with every other industry, the foundry has felt the trend of the times toward specialization and the result is becoming more apparent every day not only in the operating end, but also in the executive department. Foundrymen are losing that comprehensive grasp which characterized their predecessors and are becoming specialists. Thus, the man on the operating end bends all his energies to increasing his output and decreasing his costs. Disposing of the output at a profit, financing the business, securing orders and making collections do not interest him to any extent. He lets George do the financial worrying and since it is human nature to minimize the troubles of others and magnify our own, anything that interfere with his schedule assumes alarming proportions. He is intimate with every detail of manufacture and realizes that highly skilled help in many cases and a certain degree of skill in all cases, is required of the foundry employes. He has noted a steady decline in recent years in the number of boys or young men willing to enter the foundry to learn the molders trade. In the case of heavy machinery, engine and general jobbing shops, where a high degree of manual skill is essential, this is very evident. He is wondering, and has been wondering for some time, where this class of help is to be recruited when the present working generation has retired from active production. During the past year or two the problem has not been acute, owing to curtailed operation. However, with returning prosperity and an ever widening market as the needs of the country increase, the problem will become real and pressing. Partly owing to economic conditions and partly to restricted immigration, the question of securing an adequate amount of foundry help, both common labor and that known as semi-skilled, or machine operators, marks a similar menace.

Foundry executives who are not familiar with manufacturing details, except in a general way, and who specialize in the selling and financial end of the business, are inclined to minimize the operators' problems and to dismiss his fears for the future with a wave of the hand. They point to innumerable instances in the past where production apparently was against a stone wall on account of lack of manual labor and in every case mechanical equipment was designed to surmount the obstacle. They are calmly confident that the same or some other equally satisfactory solution will be found for the foundry labor problem when it really becames acute. In the meantime, their major problem is to sell their castings at a profit, and they trust that production will adjust itself.

Trade Outlook in the Foundry Industry

EXCEPT for the seasonal dullness in a few lines, general business conditions continue to improve in every quarter. Nor is the foundry industry an exception to the rule. Automotives predominate as the largest contributing factor to foundry prosperity, while railway, constructional and general jobbing demand is improving. Heavy machine tool plants still are lagging, although some have converted their facilities to other uses and are enabled to maintain a fair schedule of operation. Labor shortages continue to grow in a few of the larger centers, and it is confidently predicted that the next few months will see this condition become acute.

Labor Need Grows

Detroit, which in the past few years has experienced a recurrent condition of feast and famine, following the fortunes of automotive lines, again is confronted by a labor shortage. The Detroit Employers' association reports that in the first week of June, 173,206 persons were employed by the same firms which in January had only 102,485 on the payrolls. At the first of June it was reported that only 14 per cent less people were employed than during the 1920 peak, while production has increased steadily during the entire month. Consequently, Detroit is face to face with a serious labor shortage, while the same condition confronts foundries in Toledo, Cleveland, Chicago and other large centers where the development of demand in all lines has been so rapid. Automobile sales have slackened slightly as was expected during the midsummer season, but the number of cars shipped during the first three weeks of June indicates that that month will have shown an increase over the total of 256,302 automobiles manufactured during May, given in statistics issued by the department of commerce.

Car Awards Hit Peak

According to figures compiled early in July, over 14,400 freight cars were awarded during June. Compared with the May total of 18,240 and the April orders of 31,490 cars, this represents a drop; but the total domestic car awards for the first half of the year were 101,625, an aggregate which has not been exceeded in the past 10 years. This activity is reflected in foundries where railway orders have furnished a steadily increasing demand during the past three months. However, castings prices for railway work still continue at a low figure. Steel castings are said to have been placed as low as 3.9c a pound and malleable castings at slightly in excess of 6c a pound, both instances being furnished by contracts placed by railway equipment manufacturers. Railway requirements are not yet covered, inquiries being reported for 30,000 cars from a large eastern line, and in addition over 16,000 cars are pending, inquiries having been made. Heavier shipments are reported and a peak load is expected when the early fall coal shipments start. The average number of surplus freight cars in the period from June 8 to 15 fell to 268,863, compared with 284,189 cars for the first week of June.

Pig Iron Climbs

Production of pig iron, according to statistics compiled by *The Iron Trade Review*, reached a total of 2,356,418 tons in June, compared with the May output of 2,309,348 tons. This large tonnage was attained despite adverse operating conditions and the shorter month. The daily average production was at the rate of 78,547 tons, as compared with 74,495 tons in May. This represents a gain of 4052 tons per day or about 5.5 per cent increase. The total output of merchant iron in June was 414,361 tons, indicating a gain of 3957 tons over the total of 410,404 tons for May. The average daily production of merchant iron was 13,812 tons as compared with the May total of 13,239 tons. Seven merchant stacks were put into service during the month and one was blown out. The coal strike, up to the present, has not hampered iron production; but the situation is more tense and probably during present month a number of furnaces will be forced to close unless conditions are changed materially. Foundry iron purchases have been but little affected. Some buying is reported into the fourth quarter, but sales have not been heavy enough to influence prices to a marked degree. Coke still is ample in most cases to supply foundry requirements, although some slight anxiety with increased buying in the eastern centers has resulted in higher prices. Building construction continues to supply a steady demand for foundry products. According to statistics compiled by the department of commerce, 150,475 bath tubs were ordered in May as compared with 107,566 in April, while other sanitary ware kept pace.

Prices of Raw Material for Foundry Use

CORRECTED TO JULY 6

Iron		Scrap	
No. 2 Foundry, Valley	$24.00	Heavy melting steel, Valley	$17.50 to 17.75
No. 2 Southern, Birmingham	18.00 to 20.00	Heavy melting steel, Pitts	16.50 to 17.00
No. 2 Foundry, Chicago	24.00 to 24.50	Heavy melting steel, Chicago	15.00 to 15.50
No. 2 Foundry, Philadelphia	26.64 to 27.14	Stove plate, Chicago	16.50 to 17.00
No. 2 Foundry, Buffalo	24.50 to 25.00	No. 1 cast, Chicago	17.50 to 18.00
Basic, Valley	25.00	No. 1 cast, Philadelphia	19.00 to 20.00
Basic, Buffalo	24.50 to 25.00	No. 1 cast, Birmingham	14.50 to 15.00
Malleable, Chicago	24.00 to 24.50	No. 1 cast, Buffalo	17.00 to 17.50
Malleable, Buffalo	24.50	Car wheels, iron, Pittsburgh	19.50 to 20.00
Coke		Car wheels, iron, Chicago	18.50 to 19.00
Connellsville foundry, coke	$8.50 to 9.00	Railroad malleable, Chicago	17.50 to 18.00
Wise county foundry, coke	7.00 to 7.50	Agricultural mal., Chicago	17.50 to 18.00
		Railroad malleable, Buffalo	17.00 to 17.50

Brass Shops Busy

Influenced by the constructional and automotive demand, brass and aluminum foundries are increasingly active. The latter class of foundries in particular is favored through the greater use of aluminum brought about by competition in the automobile field. Nonferrous prices, based on New York quotations in the *Daily Metal Trade* of July 6 follow: Casting copper, 13.25c; electrolytic copper, 13.87½c to 14.00c; Straits tin, 31.50c; antimony, 4.95c; lead, 5.75c; aluminum No. 12 alloy, producers' price, 19.00c to 19.20c and open market, 16.00c to 16.50c. Zinc is 5.45c to 5.50c E. St. Louis. The June average prices for nonferrous metals, based on New York quotations follow:

(New York Quotations)

Casting Copper	Electro. Copper	Lead	Tin Straits	Antimony	Aluminum 98-99	Zinc St. Louis
13.35	13.913	5.781	31.551	5.131	18.10	5.355

Comings and Goings of Foundrymen

ARTHUR J. TUSCANY, recently elected secretary-manager of the Ohio State Foundrymen's association, with headquarters at 511 Wade building Cleveland, has been treasurer, director of purchases and a member of the board of directors of the Whitney Tractor Co., an association he has maintained for the past two years. Prior to that he had been sales manager and a director of the Post Tractor Co., Cleveland, which was consolidated with the previously mentioned firm. For eight years he was with the Johns-Manville Co. first as secretary to the branch manager; then he handled purchases and orders; next he went into the sales department and after some time in the field became assistant manager which position he held for three years. He was educated in the Cleveland elementary and high schools, spent a year in preparatory school and seven years in evening study, first on business subjects and later, mechanical engineering.

Louis A. Brisolese, recently has been appointed shop foreman of the Enterprise Foundry, San Francisco.

Herman R. Rire, formerly production manager of the Maytag Co., Newton, Iowa, now is secretary of the Crown Foundry Co., Peoria, Ill.

Edwin H. Heinen has been promoted from the position of foreman to that of assistant general foreman at the foundry of the General Electric Co., Schenectady, N. Y.

William H. Nank has resigned as auditor of the Carroll Foundry & Machine Tool Co., Bucyrus, O., to become a branch manager of the Mason Tire & Rubber Co., Kent, O.

John E. Smith who for some time has been one of the leading molders has been promoted to the position of assistant foundry foreman at the plant of the General Electric Co., Schenectady, N. Y.

John Wesley Haynes who formerly worked as a molder for the Hess-Snyder Co., Massillon, O., has accepted the position of foundry foreman with the Mahoning Foundry Co., Youngstown, O.

James J. Zimmerman until recently assistant superintendent of the Scott foundry department of the Reading Iron Co., Reading, Pa., has joined the engineering force of the Elliott Co. of Pittsburgh and Jeannette, Pa., builders of condensers and steam equipment.

Harry Goldstein, formerly brass and aluminum foundry superintendent, Michigan Motor Castings Co. of the Buick Motor Corp., Flint, Mich., has been made general superintendent of the gray iron foundries succeeding Thomas P. Greenhow who will engage in consulting engineering work in the foundry lines.

Connecticut Foundrymen Elect Officers

At the annual meeting of the Connecticut Foundrymen's association held at the Seaside club, Bridgeport, Conn., Tuesday evening, June 20 the following officers were elected: President, F. W. Stickle, Capitol Foundry Co., Hartford; vice president C. E. Bilton, Bilton Machine Tool Co., Bridgeport; Secretary, C. S. Neuman, Union Manufacturing Co., New Britain; treasurer, J. M. Woolson, Estate of S. H. Barnum, New Haven; Directors: B. W. Spencer, Bradley & Hubbard Manufacturing Co., Meriden; A. F. Corbin, Union Manufacturing Co., New Britain; F. B. Farnsworth, McLagon Foundry Co., New Haven; G. A. Ray, Taylor & Fenn Co., Hartford, and S. Reynolds, Putnam Foundry & Machine Co., Putnam. The subject for discussion, following the election, was Sand: for Molding, for Cores and for Sandblast. The association is now entering upon its fourth year with a membership of forty-five.

Southern Metal Trades Meet in Savannah

An outstanding feature of the 5th annual convention of the Southern Metal Trades association held in Savannah, Ga., June 19 and 20 was the address delivered by T. M. Cunningham, Jr., president of the Chatham Savings & Loan Co., Savannah, Ga. He dwelt at considerable length on emigration laws; the recent decision of the United States supreme court as handed down by Chief Justice Taft in the Coronado Coal case; government ownership of railroads; joint responsibility of capital and labor associations; the ship subsidy bill; the child labor law and others. Pat Dwyer, engineering editor, THE FOUNDRY, Cleveland, read a paper, "Sidelights on Cupola Practice," in which he directed attention to many popular misconceptions still prevailing among foundrymen on the subject of melting iron. The first day's session was concluded by a banquet at the Hotel Savannah.

A short business session was held on the second day to receive the reports of the secretary, W. E. Dunn, Jr.; the treasurer, J. W. Moore and the chairman of the research committee, M. M. Hedges. At this session officers were elected for the ensuing year as follows: President, J. H. Dore, Houston Car Wheel & Machine Co., Houston, Tex.; vice president, M. M. Hedges, Casey-Hedges Co., Chattanooga, Tenn.; secretary, W. E. Dunn, Jr., Candler Bldg., Atlanta, Ga. In the afternoon the Savannah foundrymen acted as hosts at an outing and shore dinner on Tybee island at the mouth of the Savannah river.

The state vice presidents include: W. S. Pfohl, Briggs Shaffner Co., Winston Salem, N. C.; T. H. Siddall, Sumter Machinery Co., Sumter, S. C.; John S. Schofield, Schofield's Sons Co., Macon, Ga., J. M. Broom, Ocala Iron Works, Ocala, Fla.; E. W. McDonald, Talladega Foundry & Machinery Co., Talladega, Ala.; E. F. Billington, Soule Steam Feed Works, Meridian, Miss.; T. L. LaMalta, Chickasaw Machinery & Foundry Co., Memphis, Tenn.; E. L. Dilley, Standard Brakeshoe & Foundry Co., Pine Bluff, Ark.; Chas. R. Law, DeSoto Foundry & Machinery Co., Mansfield, La.; W. C. Trout, Lufkin Foundry & Machinery Co., Lufkin, Tex. Memphis, Tenn., was recommended for consideration as the place for the next convention.

Industrial Engineers Add Department

At the annual meeting of the F. J. Ryan Co., Industrial Furnace Engineers, Wesley Building, Philadelphia, the following officers were elected: President, F. J. Ryan; vice president, W. W. Posey, president Lancaster Iron Works, treasurer, A. C. Scully, Lancaster Iron Works; secretary Miss E. N. Kraske; and S. R. Vanderbeck, Philadelphia, was re-elected director. G. F. Beach, for a number of years chief engineer of the Mircs furnace department of the Lan-

caster Iron Works and who came into a like position when the company was merged with the Ryan Co., in the same work. The consolidated company has decided to take on additional departments covering producer gas and regenerative furnaces. This work will be under the direction of Karl G. Gustafson who has had extensive experience along these lines in France and Germany.

New Radial Grinder

To meet the demand for a machine to do grinding with maximum power over a large area a flexible radial grinder has been put on the market by the Stow Mfg. Co., Binghamton, N. Y. It is suspended from the ceiling and operates over a 20-foot circle. The unit is simple in construction and is belt driven directly from the line shaft or motor, thus making a countershaft unnecessary. This too is made for the operation of abrasive wheels and wire scratch brushes for work on automobile bodies, large castings and similar applications. The long flexible shaft, shown in the accompanying illustration, makes it adaptable for work on large pieces. The grinder may, if desired, be equipped for drilling or with a screw driver for assembling. The weight of the flexible shaft is counterbalanced so that the worker has the tool within easy reach and control.

NEW TYPE ELECTRICALLY DRIVEN FLOOR GRINDER

Develop New Code for Conveying Units

Through a recent decision of the American Engineering Standards committee, 29 West 39th St., New York, an important step toward a solution of the accident problem will be undertaken in the deveiopment of a safety code for conveyors and conveying machinery. Introduction of mechanical conveyors in many industries has eliminated the large proportion of the accidents resulting from the manual handling of materials, but at the same time it has introduced new hazards, many of which can be prevented by a more general agreement among both users and manufacturers of conveying equipment as to safe practices in the manufacture, installation and operation of such equipment.

This code according to the committee will be intended as a guide for the safe operation and maintenance of conveyors and conveying machinery coming under the following main divisions: Gravity, belt, chain, flight buckets, apron, screw and jigging conveyors, car hauls, aerial cableways, overhead trolleys and pneumatic tubes. All shafting, pulleys, belts, link belts, chains, gears, sprockets, couplings, clutches, etc., used on and in connection with conveyors and conveying machinery will be covered in the mechanical power transmission code now in the course of preparation.

Completes New Shop

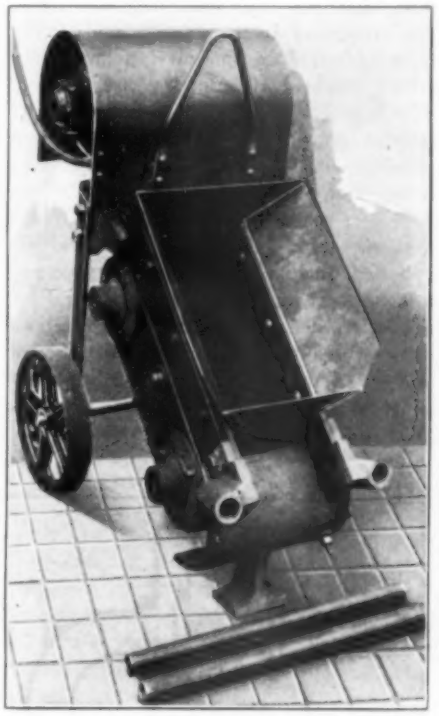
Fremont Castings Co., controlled by interests owning the Curtis & Marble Machine Co., textile machinery builders recently has completed a new foundry at 105 Fremont street, Worcester, Mass. The building, 90 x 205 feet, one story with monitor roof is divided into two rooms each containing 8700 square feet of floor space. One room is to be used for making the molds and the other contains the core ovens, cupola, charging platform, blower and cleaning rooms. The carpenter shop is at one end of the building. The molding room is spanned by an electric traveling crane and the iron will be melted in a Paxson-Colliau cupola with an approximate daily capacity of 20 tons. The foundry is equipped with molding machines and other equipment for handling either light or heavy castings. Officers of the company are: President, Edwin H. Marble; vice president and superintendent, Herbert A. Davis; treasurer, Charles F. Marble; secretary, Harry A. Wilber; and directors, William C. Marble and Albert C. Marble.

E. J. Byerlein, formerly sales engineer for the Osborn Mfg. Co., Cleveland, now is operating the Milwaukee Foundry Equipment Co., 57 Erie street, Milwaukee.

Zirconium ores are widely distributed in the United States, possibly the largest commercial deposits are those located in Florida.

Centrifugal Force Is Used to Blend Sand

Working along an original line, the Royer Foundry & Machine Co., Wilkes-Barre, Pa., has developed the sand separator and blender shown in the accompanying illustration. The device was on exhibition at the company's booth at the recent foundry show in Rochester, N. Y., and demonstrated the manufacturer's claim that it was capable of producing a barrow full of clean sand from a dirty sand pile in two minutes. The combined principles of the harrowing, gravity and centrifugal force are utilized in the operation of the machine. Sand is shoveled into a hopper in which the bottom is formed by a rapidly moving endless belt thickly studded with steel sprigs. The sprigs comb the bottom surface of the sand, the small particles of sand fall between the sprigs and all foreign material gravitates toward the lower end of the hopper where it may be removed while the machine is in motion. Centrifugal force exerted at the point where the belt emerges from the hopper and passes around the pulley, discharges the fine sand from between the sprigs. The sand is areated by being thrown through the air for a considerable distance in a fluffy stream. The machine, simple and rigid, is mounted on wheels and easily may be moved from place to place.

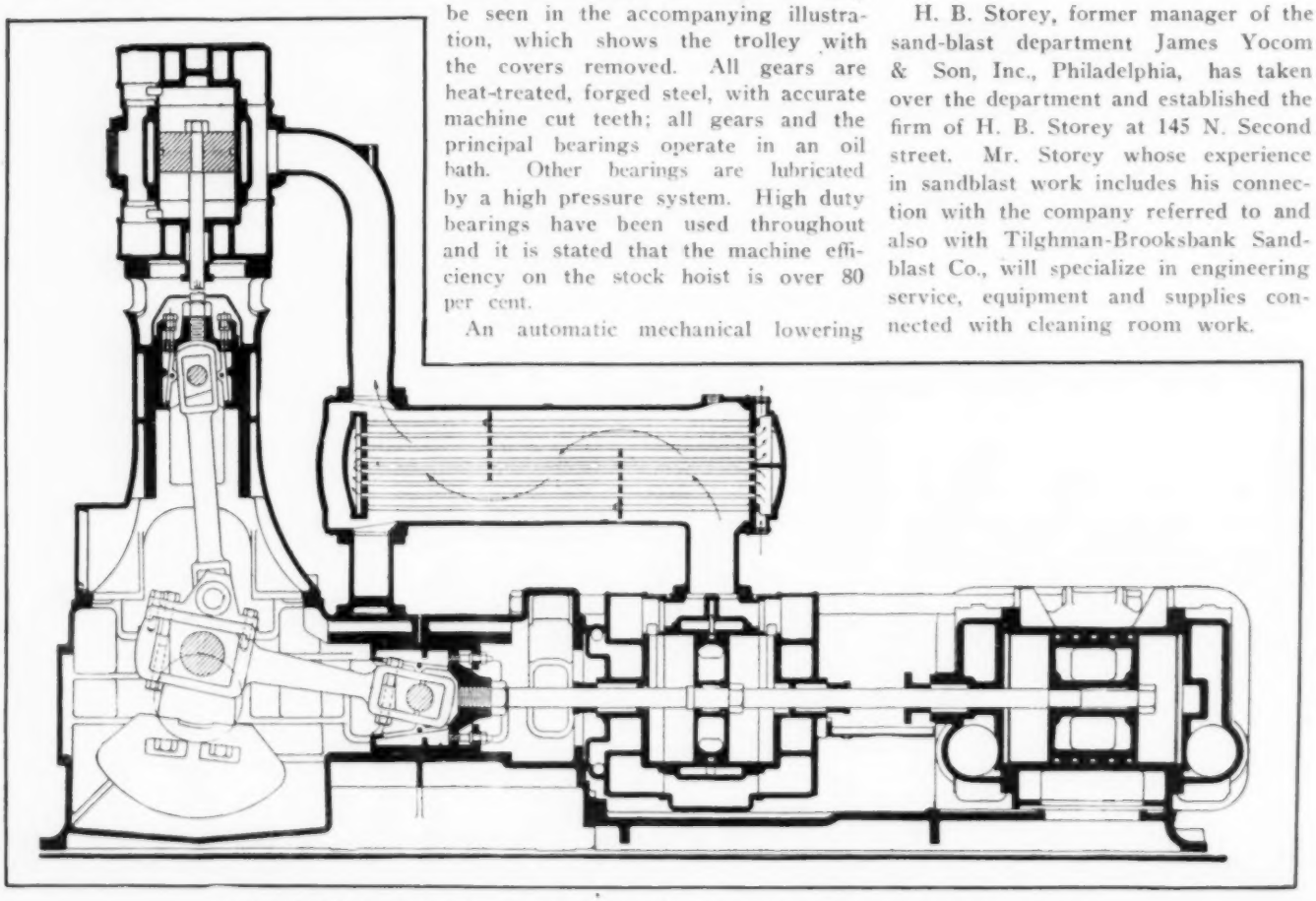


THE RAPIDLY MOVING BELT IN THE BOTTOM OF THE HOPPER CLEANS AND BLENDS THE SAND

Steam Driven Compressor of Large Capacity

After operating one of these machines in its Chicago plant for some time the Sullivan Machinery Co., Chicago, has placed on the market a new type of steam driven air compressor with a capacity of 1000 feet and upward. The machine is shown in the accompanying illustration which is a center line sectional view. The steam end consists of a 4-valve cylinder with the element of initial condensation reduced to a low factor by the arrangement of the inlet and discharge valves which provide for the flow of steam from the inlet to exhaust in a direct path and for high compression. The new machine is an adaptation of the familiar angle compound type formerly either direct connected or belt driven. The low pressure cylinder is on a horizontal plane in line with the steam cylinder and the high pressure cylinder is vertical. A single, high duty steam cylinder placed at the rear of, and tandem with, the low pressure air cylinder, furnishes the necessary power for operating the compressor. A heavy fly wheel mounted on one end of the crankshaft imparts a smooth and even motion to the machine. A single crankpin serves to drive both low and high pressure pistons.

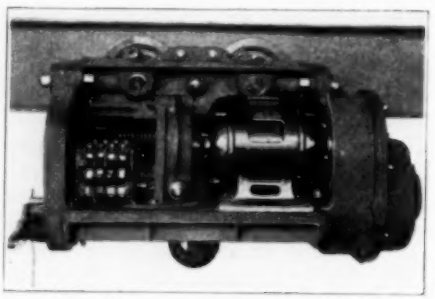
The intercooler for removing the heat of compression in the air discharged from the low pressure cylinder is a substantial cylindrical cast iron shell located above the low pressure cylinder. It is provided with a nest of copper or aluminum tubes through which cooling water circulates.



CENTER LINE SECTION OF STEAM DRIVEN ANGLE COMPOUND COMPRESSOR

Introduce New Monorail Electric Hoist

The Standard Electric Crane & Hoist Co., 1420 Chestnut St., Philadelphia, has developed a new monrail electric hoist. The feature that is emphasized in this machine is the short headroom required. On the 3-ton capacity hoist an effective working headroom of only 14 inches is sufficient.



ELECTRIC HOIST TROLLEY WITH COVERS REMOVED

The construction is simple as may be seen in the accompanying illustration, which shows the trolley with the covers removed. All gears are heat-treated, forged steel, with accurate machine cut teeth; all gears and the principal bearings operate in an oil bath. Other bearings are lubricated by a high pressure system. High duty bearings have been used throughout and it is stated that the machine efficiency on the stock hoist is over 80 per cent.

An automatic mechanical lowering brake is provided to control the speed while lowering. It is of the screw and disk type, geared to the intermediate shaft and having three disks. The holding brake works on a pulley mounted on the hoisting motor shaft and is lined with asbestos brake band lining. It is operated by a cam on the controller shaft and will hold the load at any point. These machines are manufactured in five types with a hoisting speed ranging from 10 to 140 feet per minute and a capacity of from 2000 to 10,000 pounds.

Completes New Steel Casting Shop

The Lorain Steel Co., Johnstown, Pa., recently has completed the construction of a new addition to its open-hearth plant. The extension will have a 6-ton and a 3-ton electric furnace, both of the heroult type. The new foundry which covers 320 x 160 feet is equipped with two 15 and one 10-ton traveling cranes, and complete molding machine, core room and cleaning facilities to handle street car track work, mill, mine car and railway steel castings. G. W. Merrefield is superintendent; J. J. Walsch and W. J. Watkins are assistants.

H. B. Storey, former manager of the sand-blast department James Yocom & Son, Inc., Philadelphia, has taken over the department and established the firm of H. B. Storey at 145 N. Second street. Mr. Storey whose experience in sandblast work includes his connection with the company referred to and also with Tilghman-Brooksbank Sandblast Co., will specialize in engineering service, equipment and supplies connected with cleaning room work.

Sales Follow Upward Trend

Increase in Foundry Activity Marks Trend in Demand for Equipment and Supplies—New Projects Are Expected—Additions Are Contemplated in Some Sections to Increase Capacity

STEADILY improved conditions in foundry operations are reflected in the increasing demand for foundry equipment and supplies. Sales of light equipment, flasks, wheelbarrows, and small tools predominate in forming an active market, characterized by the rapid replacement of inquiries with orders. The Taylor-Brown Co., Worcester, Mass. recently has taken over the Eidder Co. and the Walter B. Taylor Brass Foundry and will produce aluminum, brass and other nonferrous castings. The Tilbury Iron Works has absorbed O. J. Cavanagh & Co., Tilbury, Ont. and are building an addition.

Demand Indicates Activity in Pittsburgh

EXCEPT insofar as it is interfered with by the coal strike, the foundry equipment trade in the Pittsburgh area is exceedingly active. Most foundries, except those making castings used in mining machinery are growing busier and many have to purchase additional equipment. Inquiries therefore are numerous and sellers of the larger machinery as well as distributors of the smaller supplies used in foundries are greatly encouraged, particularly over the fact that so many inquiries turn promptly into orders. These orders originate in various parts of the country indicating that the demand is widespread. Recent purchasers of sand mixers include the P. & F. Corbin Co., New Britain, Conn. The Patterson Foundry Co., East Liverpool, O., bought a 3-ton worm-geared ladle and the Whiting Corp., reports the sale of two or three additional ladles to users located near by. Platform scales have been purchased for the foundry at the Auburn prison, Auburn, N. Y., and the Lima Locomotive Works, Lima, O., closed on a portable core oven. Several other core oven propositions still are pending. Cupola inquiries are not now so numerous as a few weeks ago, only one or two being considered alive. Orders for wheelbarrows from local foundries as well as from more remote centers are plentiful as are orders for flasks, riddles, shovels, the smaller supplies and facings. Recent wheelbarrow orders have called from two to a dozen at a time and this also is more or less true of flasks. All this indicates activity on the part of numerous foundries and sellers of equipment report that quite a number which have been idle or practically so for some time past now are active. This also is indicated in a certain measure by the large number of molding machine inquiries in hand. Recent buyers of the Herman Pneumatic Machine Co.'s equipment include the Phoenix Iron Works, Meadville, Pa., and the Warren Foundry & Machine Works, Phillipsburg, N. J., one large rollover machine each. The Keystone Driller Co., Beaver Falls, Pa., bought one large rollover molding machine and a plain jarring machine. Pittsburgh district foundries have not been purchasing many cranes of late, although hoist orders and inquiries are fair. The C. L. Miller Co., Scottdale, Pa., has purchased three 3-ton electric hoists from the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., while the Cambria Steel Co., purchased six 1-ton hoists from this builder. It also sold several to the Morrow Mfg. Co., Wellston, O.; one 3-ton hoist to the Garford Works Co., Elyria, O.; and one 2-motor pit riveter monorail electric hoist to the Greenville Steel Car Co., Greenville, Pa. which is understood to be a prospective purchaser of considerable foundry and other equipment. The Gulf Welding & Machine Works, Beaumont, Tex., and the South Boston Mfg. Co., South Boston, Va., also are reported to be in the market for a considerable quantity of foundry machinery.

Chicago Sales Active

Although much prospective business in foundry equipment is highly tentative and does not result in actual orders, especially as the vacation and inventory season is at hand, much more interest is being shown by foundry operators, who seem to be of the opinion they must buy further equipment to keep up with increased operations. This condition is intensified by considerable inquiry from engineering concerns which are outlining new plants or changes in existing foundries. A large foundry in the vicinity of Chicago now is being figured and probably will go forward. Railroad shops are offering considerable prospective business in this line as well as in most others, and especially in cranes promise to be important factors. A number of cupolas are about ready to be placed, and general demand for ladles, charging cars, coke cars and similar smaller pieces of equipment are being bought, indicating the need for renewed equipment in many foundries now becoming active after the lull. The Clauder-Welton Die & Machine Co., Bethlehem, Pa., has ordered a No. 4 cupola and complete foundry equipment from the Whiting Corp., Harvey, Ill. The Bucyrus Co., Milwaukee, has bought a 36 x 48 inch tumbling barrel, and the Union Steel Castings Co., Pittsburgh, a 48 x 60 inch tumbling barrel from the Whiting Corp. Crane sales by this maker include the following: One 5-ton electric crane, 38-foot span for the Cadillac Malleable Foundry, Cadillac, Mich.; one 15-ton hand power crane for the Northeastern Power Co., Milwaukee; one 10-ton electric crane for Fairbanks, Morse & Co., Beloit, Wis.

What the Foundries Are Doing

Activities of the Gray Iron, Malleable, Steel and Brass Shops

The Wilson Foundry & Machine Co., Pontiac, Mich., plans to approximately double its present output.

The Tennessee Coal, Iron & Railroad Co. is reported planning to remodel its foundry at Ensley, Ala., for the manufacture of ingot molds and iron castings.

Improvements to its foundry and machine shop, including the installation of new equipment, is planned by the South Boston Mfg. Co., South Boston, Va. J. L. Watkins is secretary of the company.

The Bethlehem Foundry & Machine Co., Front street, Bethlehem, Pa., has acquired the plant and business of the Wedge Me-

chanical Furnace Co., Greenwich Point, Philadelphia.

Clark's Iron Foundry has been incorporated to take over the plant and business of J. Alfred Clark, deceased, Philadelphia.

Erection of a modern foundry building is reported under consideration by the Chickasaw Shipbuilding & Car Co., Fairfield, Ala.

Plans are being prepared by the Burr Pattern Co., Detroit, for the erection of a factory building, 2-stories, 40 x 100 feet.

The foundry at the plant of the Continental Heater Co., Dunkirk, N. Y., recently was damaged by fire.

Erection of an addition to its plant is under consideration by the Standard Mold Co., Akron, O.

The Industrial Steel Castings Co., Toledo O., recently purchased a site adjoining its present plant.

Capitalized at $50,000 the Keystone Foundry Co., Lebanon, Pa., recently was incorporated by John G. Kreider and others.

Erection of a foundry building is under consideration by the Crucible Steel Castings Co., Cleveland.

Work is expected to be started soon by the Calumet Tank & Mfg. Co., Hammond, Ind., on the erection of a foundry building, 1-story, 60 x 130 feet.

Contract has been awarded to the Truscon Steel Co. by the Essex Foundry, Newark, N. J., for the erection of an addition to its plant, to be 100 x 120 feet.

Plans are being prepared by the American Woodworking Machinery Co., Rochester, N. Y., for the erection of a foundry building, to be 110 x 130 feet.

The C. L. Dorer Foundry Co., Bellaire, O., has had plans prepared for the erection of an addition to its foundry, 1-story, 36 x 60 feet.

Plans are being prepared by the Susquehanna Casting Co., Wrightsville, Pa., for the erection of a foundry building at New Oxford, Pa.

The Meeker Foundry Co., South Norwalk, Conn., is planning to build its plant which was recently damaged by fire. Plans have not been completed as yet.

Contract for the erection of a 1-story, 54 x 86-foot addition to its foundry recently was awarded by the Arcade Malleable Iron Co., Worcester, Mass.

The Toledo Aluminum, Bronze & Castings Co., Toledo, O., has purchased a factory building which it will improve and enlarge for its own use.

Capitalized at $100,000, the K-T Foundry, Ltd., Galt, Ont., recently was incorporated by James R. Fergusson, David J. Fleming and Arthur D. Ward.

The Empire Brass Foundry, 128 Wellington street, Montreal, Que., plans the erection of an addition to its plant and will install some new equipment. W. H. Madigan, 939 Atwater street, has the general contract.

The Oil Tool Service Mfg. Co., Anaheim, Cal., has plans for the erection of a machine shop and foundry at Santa Ana and Atchison streets, Anaheim. B. D. McAlvay and M. N. Putnam are officers of the company.

The Ramm & Yahl Brass Foundry Co., Ft. Wayne, Ind., which was recently organized, is expected to start operations soon in the former plant of the Zimmerman Carpet Cleaning Co., 1911 St. Joe boulevard. Castings of brass, aluminum, bronze and copper will be manufactured.

The Ironide Foundry, Inc., Ware, Mass., has been incorporated with a capital stock of $50,000 to specialize in the manufacture of special castings. It has purchased an abandoned street railway carhouse and expects to begin operations shortly. Officers of the company are: President, E. A. Johnson; vice president, Myron E. Vaughn; treasurer, Stephen Jones and clerk and shop manager, M. T. Eckmann.

Contract has been let by the Portsmouth Stove & Range Co., Portsmouth, O., to the Ferro-Concrete Construction Co., Cincinnati, for the erection of an addition to its plant. The company has placed an order with the George J. Hagan Co. for ovens and other equipment.

Recently organized, the Enterprise Foundry Co., Ft. Wayne, Ind., will establish a plant at High and Clark streets, Ft. Wayne. A 1-story building, 30 x 120 feet, and a 2-story structure of the same ground area, have been acquired and the company is installing equipment. Small gray iron castings will be specialized in.

Thomas Savill's Sons, 1310 Wallace street, Philadelphia, manufacturers of pipe, plumbing equipment, etc., have awarded contracts to Seeds & Steinmetz, 1101 Divinity place, for the erection of a foundry building, 2-stories, 42 x 60 feet, at 635-37 North Watts street. H. B. Wadlon, 10 South Eighteenth street, is architect.

Contract has been awarded to the Belmont Iron Works, Twenty-second street and Washington avenue, Philadelphia, by the N. & G. Taylor Co., 300 Chestnut street, Philadelphia, for the erection of a 1-story foundry building, 50 x 90 feet, and a 1-story general manufacturing building, 75 x 140 feet, at Cumberland, Md.

The Cadillac Malleable Iron Co., Cadillac, Mich., was incorporated recently with $350,000 capital stock to manufacture malleable iron castings, etc. Officers are: President, J. C. Ford; vice president, C. T. Mitchell; secretary and general manager, R. J. Teetor and treasurer, George G. Brown. Construction of the company's plant was started last year but work was delayed and it now is being completed. Equipment is being installed and it is expected the manufacturing operations will start late in the summer.

New Trade Publications

AUTOMATIC STOKER—Automatic stokers for small plants are described and illustrated in a folder recently published by the Combustion Engineering Corp., New York.

WELDING RODS—The Page Steel & Wire Co., Bridgeport, Conn., is circulating a 40-page illustrated booklet in which welding rods and electrodes for oxyacetylene and electric welding are described and illustrated. In addition, some general information is given in the booklet.

TRUCKS—The Commercial Truck Co., Philadelphia, is circulating a 4-page illustrated folder in which an electric truck is described and illustrated. Some of the features of this truck as pointed out in the leaflet are good balance; all instruments under the hood; battery accessible without going through the body; short wheel base and turning radius; large motors.

PULVERIZED FUEL SYSTEM—The Combustion Engineering Corp., New York, has published a 30-page illustrated booklet containing a comprehensive treatise on the application of pulverized fuel to the locomotive. It tells of the most interesting phases of the company's pioneer work in this field and gives a number of informative test reports.

CUTTING METAL—The Chesterfield Metal Co., Detroit, is circulating a 4-page folder in which a noncorrosive, nonmagnetic alloy of nickel, cobalt, tungsten and other semirare metals, combined to produce a cutting metal, is described. In grinding this metal, the booklet points out, only necessary front clearance should be given, from 2 to 6 degrees.

COUNTERBORE—The Bickford-Switzer Co., Greenfield, Mass., has published a small folder in which a newly designed counterbore is described and illustrated. According to the folder this counterbore has two lips and, because of its ample clearance and spiral flutes, it will cut faster and wear longer. Chattering is eliminated and there is room for convenient sharpening. The body is circular between the cutters, maintaining a pilot until the tool is worn out.

PYROMETERS—Wilson-Maeulen Co., Inc., New York, has published a 20-page illustrated booklet in which pyrometers, pyrometer recorders, etc., are described and illustrated. A multi-record, multi-color pyrometer recorder is among the equipment described. This operates with base metal or rare metal thermocouples in thermo-electric pyrometer service. It also operates as a low-temperature recorder or electrical resistance thermometer in connection with resistance thermometer bulbs. Full details are given in the booklet, which also includes descriptions of parts, accessories, etc.

BOLTS AND NUTS—The Selflock Nut & Bolt Co., Inc., Syracuse, N. Y., is circulating a 4-page illustrated leaflet in which track bolts and nuts are described and illustrated. A number of tests are described. According to the folder threads of these nuts are equal in area and in strength to standard threads and differ only in the shape of their cross-section. Compared to a standard thread the base of a self-locking thread is deflected a few thousandths of an inch. Other details are given.

FIREBRICK—The Evans & Howard Fire Brick Co., St. Louis, has published a 50-page illustrated booklet in which fire brick and refractory material for blast furnaces, open-hearth furnaces, malleable furnaces, annealing ovens, copper, zinc and lead furnaces, cupolas, boiler settings, etc., are described and illustrated. The shapes illustrated have been selected from a large number heretofore made by various manufacturers, and which have been adopted by the members of the Refractories Manufacturers' association as standard.

GRATE BARS—The Thomas Grate Bar Co., Birmingham, Ala., has published a number of 4-page leaflets in which grate bars are described and illustrated, and their applications pointed out. In operation the elliptic shaped grate bar which has an eccentric movement slips under the fuel or fire bed, peels the ash from its lodgment and deposits into ash pit and does not disturb the fire, tearing the fuel bed into streaks, seams, holes and pockets. As a result the fire is kept at the highest state of efficiency.

SAND CUTTING MACHINE—The American Foundry Equipment Co., New York, is circulating a 12-page illustrated booklet in which a power sandcutting machine is described and illustrated. The machine is built upon a frame of seamless steel tubing. The front wheels are of caster type mounted in inclined forks. The machine steers by the hand like a pushcart, and can make short turns. The drive wheels are of the tractor type driven by a motor through a differential shaft with spur pinion at each end, engaging with ring gear on each tractor wheel. The motor runs forward or reverse and at high or low speed. The cutting cylinder, shield, motor and transmission are carried upon an approximately balanced frame. By tilting the frame backward the cutting cylinder is lowered into the sand and vice versa. A complete description of the machine is given.